Thermography in Diagnosis of Radiculopathies

Article by Thomas C. LaBorde, Clin J Pain 1989;5:249–253
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CONDENSATION

Purpose of Study

To review the basic scientific literature with regards to sensitivity, specificity, and reliability of neuromuscular thermography in identifying radicular pathology and to address the criticisms and skepticism of thermography

Background

In order to understand the scientific literature as it relates to the validity of new diagnostic procedures it is necessary to understand *the terms* used for the scientific assessment. The following terms are often used in evaluating a new diagnostic procedure (Gelfand & Ott, 1985; O'Brien & Shampo, 1981).

- *Prospective Study:* The imaging investigation is designed and conducted prior to the accumulation and organization of the test results. Considered by some to be superior to retrospective studies.
- *Retrospective Study:* The investigation consists of reviewing data that is already available from previous cases.
- *Single-Blinded Study:* When used for imaging methods, the clinical information is withheld from the interpreter.
- *Double-Blinded Study:* Double-blinded studies are only appropriate in the evaluation of drugs and therapeutic procedures and have no application in the assessment of diagnostic imaging methods (Gelfand & Ott, 1985).
- *Reliability:* Reliability of a diagnostic procedure describes its ability to provide the same answer on repeated interpretations or on sequential examinations.
- *Interobserver Reliability:* The interpretation is done by different individuals.

Vol. 3, No. 1. Printed in U.S.A.
1041-469X/$3.00/91

- *Intraobserver Reliability:* A single interpreter repeats the interpretation.
- *Sensitivity:* The ability of an imaging method to detect pathology in a diseased population. An imaging procedure is 100% sensitive when there are no false negatives.

$$\text{Sensitivity} = \frac{\text{True positives}}{\text{True positives} + \text{False positives}}$$

- *Specificity:* The ability of an imaging method to identify normals in an asymptomatic or normal population. A procedure exhibits 100% specificity when there are no false positives.

$$\text{Specificity} = \frac{\text{True negatives}}{\text{True negatives} + \text{False positives}}$$

- *Prevalence Level:* The occurrence of disease in the general population. The average prevalence level for most diagnostic imaging modalities is in the range of 50% (Kundel, 1982).

Most diagnostic imaging methods appear in the 80% value range for specificity and sensitivity according to LaBorde.

Historical Perspective

Thermography was first discussed as a means to evaluate complex pain states in 1964 at the New York Academy of Sciences meeting. As early as 1968, Edeiken et al. reported an 80% correlation between thermographic patterns and the pathology demonstrated on myelography. Visualized thermographic changes in the extremities following dermatomal patterns due to herniated discs was first reported in 1973 by Duensing et al.

During the 1980s numerous papers dealing with the sensitivity, specificity, and predictive value in prospective, retrospective, and blinded studies appeared. As a result of these papers, many of the medical associations produced position papers concerning the scientific validity of this diagnostic procedure.

The American Medical Association's Council on Scientific Affairs (1987) completed a thorough and in-depth evaluation on neuromuscular thermography. The Council's report concluded that thermography was a valid and reliable diagnostic tool in the clinical evaluation of neurological and musculoskeletal conditions.

The Joint Council of State Neurosurgical Societies (1988), in their position paper entitled *Neurosurgical Clinical Procedure Review,* state: "Thermography is a safe and effective means for evaluation of vasomotor instability due to irritation or injury of spinal roots or sympathetic fibers. It is useful in detecting associated vasomotor instability and complex pain states associated with arthritis, soft tissue injuries, low back disease or reflex sympathetic dystrophy and does provide objective data to identify dysfunction in roots that are irritated in the

lumbar spine, peripheral nerves that are irritated and damage to the sympathetic nervous system."

The American Academy of Physical Medicine and Rehabilitation's subcommittee on assessment of diagnostic and therapeutic devices and modalities reported on the medical efficacy of thermography in the position paper entitled, *Neuromusculoskeletal Thermography* (Schwartz, 1990). The PM&R position paper states: "Thermography is a safe, non-invasive test which does not involve the use of ionizing or radiation. It is a test of physiological function that may aid in the interpretation of the significance of information obtained by other tests. Thermography can be useful in the diagnosis of selected neurological and musculoskeletal conditions. It may facilitate the determination of spinal nerve root, distal and peripheral nerve or soft tissue injuries. Thermography is useful in the diagnosis of reflex sympathetic dystrophy syndromes."

The American Chiropractic College of Thermology (1988), a college of the Council on Diagnostic Imaging of the American Chiropractic Association, promulgated a policy statement on thermography that states: "Thermography is a legitimate diagnostic methodology which is germane to chiropractic practice and which is also a potential source for chiropractic research."

Approach

The author states that there are hundreds of well-designed studies published in the world literature that support the validity, reliability, and clinical usefulness of neuromuscular thermography. The author summarizes the representative data published from the literature. The author reviews numerous retrospective studies, prospective studies, and single-blinded studies, and tabulates the data with regards to the average specificity and sensitivity.

What Investigator Accomplished

For the sake of brevity and concise presentation, the author reported the findings of published data in numerous tabular forms.

"The average sensitivity for thermography was 96% (range 85–100%)." "For asymptomatic controls, the average specificity was 94% (range, 90–100%) and on the basis of reference examination comparison, the average specificity was 68% (range, 60–75%)." (See Table 1.)

"In comparative studies, the average correlation with various reference standards was 80% (range, 68–100%)." (See Table 2.)

"Interobserver and intraobserver reliability averages 90% (range, 80–100%)." (See Table 3.)

"The average prevalence level of thermography was 49% (range, 45–56%)." (See Table 4.)

Table 1. Prospective studies of neuromuscular thermography

Study	Sensitivity (%)	Specificity (%)	Reference standard	Number of patients	Spinal level
Gillstrom, 1985	98	100	Clinical	52	Lumber
	100	(controls)	surgery	13	Lumbar
Perelman, 1985	100	75	CT	116	Lumbar
Dagi, 1983	90	—	Myelo and surgery	57	Lumbar
Pochaczevsky et al., 1982	84	—	Myelo and	61	Lumbar
	92	—	surgery	38	Lumbar
Feldman and Nickoloff, 1984	—	94 (controls)	Controls	100	Cervical
Hubbard, 1986	—	90	Controls	26	Lumbar
	—	92 (controls)	Controls	26	Cervical
Chafitz et al., 1985[a]	100	60	CT	34	Lumbar
Uricchio, 1986[a]	100	70	Myelo	22	Lumbar
	100	(myelo + CT)	CT	17	Lumbar

[a]Blind interpretation.
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When neuromuscular thermography is compared with other traditional diagnostic imaging methods in terms of specificity, one is able to gain a better perspective of the clinical value of this diagnostic procedure. The author states: "The average sensitivity for thermography (96%) is as good, if not better than, other traditional diagnostic methods (80%). The average reliability is equal or better for thermography (96%) than other imaging methods." (See Table 5.)

Table 2. Retrospective comparative studies of neuromuscular thermography

Study	Percent correlation	Reference standard	Number of patients	Spinal level
Weinstein, 1986	70	Myelo	54	Lumbar
	83	CT	206	Lumbar
	92	EMG	156	Lumbar
	100	Surgery	34	Lumbar
	75	Myelo	16	Cervical
	80	CT	46	Cervical
	98	EMG	136	Cervical
	100	Surgery	14	Cervical
Hubbard, 1986	95	Myelo	36	Lumbar
	80	CT	73	Lumbar
	68	EMG	88	Lumbar
	79	Myelo	34	Cervical
	81	CT	89	Cervical
	70	EMG	167	Cervical
Nakano, 1984	90	Myelo	43	Lumbar
	90	CT	43	Lumbar
	90	EMG	43	Lumbar

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Table 3. Blinded reading reliability in neuromuscular thermography

Study	Percent agreement	Number of patients	Number of readers
Chafitz et al., 1985	100	34	2
Maultsby et al., 1986	80	112	4

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Investigator's Observations

In spite of this scientific data that demonstrates the validity of neuromuscular thermography, there has been criticism and skepticism in the medical community. The author states: "It is a fact that most new, major technological advances are often greeted with raised eyebrows by the medical establishment. This basic skepticism is healthy in that it prompts close scrutiny and objectivity before passing judgment. However, it is unfortunate that political issues, economic issues and misinformation can often be the basis for rejection by the medical establishment. Physicians must divorce themselves from the non-scientific influence of emotion, personal bias, and politics when making objective scientific assessments. With this all important concept in mind, one can then impartially judge the evidence on its scientific merit."

COMMENTARY

This is an excellent review article that summarizes nicely in tabular form the data from the medical literature as they relate to sensitivity, specificity, and reliability of neuromuscular thermography in identifying radicular pathology. The data in this review article appear to show that thermography is equal to or better than other diagnostic procedures in evaluating radiculopathy.

From this observer's point of view, based on seven years using thermography (TG) in clinical practice and with the data reviewed in this paper, thermography is going to play a more prominent role in the future in evaluating cases of suspected radicular pathology. The mere fact that thermography is a noninvasive technique that is completely

Table 4. Prevalence level in a symptomatic population for imaging methods

Study	Method	Percent abnormal	Prevalence level (%)
Rosenblum, 1985	Thermography (318 patients)	56	56
Hubbard, 1986	Thermography (805 patients)	47	47
Uricchio, 1986	Thermography (1,288 patients)	45	45
Kundel, 1982	Radiographs, CT, myelogram	50 (average)	50 (average)

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Table 5. "False-positive" rate for imaging methods in an asymptomatic population

Study	Method	Percent abnormal	Specificity (%)
See Table 1	Thermography	6 (average)	94 (average)
Korber and Bloch, 1984	L-spine radiograph	58	42
Hitselberger and Witten, 1968	Myelogram	37	63
Wiesel et al., 1984	CT scan	36	64

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harmless, without damaging radiation, needles, or other noxious devices, makes it even more attractive to the conservative clinician.

When reviewing the papers written by Hitselberger (1968), Wiesel (1984), Weinreb (1989) and others that indicate relative high false-positive rates with anatomical testing, there appears to be a need for physiological testing procedures with a low false-negative rate. Thermography may play this vital role. Thermography, being a physiological test, complements the findings of anatomical testing. The clinician may find thermographic findings helpful in determining whether the bulging disk so often seen on MRI is functionally (physiologically) significant. This author has found thermography to be quite valuable in cases with negative or equivocal anatomical test findings where the clinical findings are suggestive of disk pathology, radiculopathy, or peripheral nerve injury. In addition, thermography is quite helpful in differentiating radiculopathy from the referred subjective pain complaints of scleratogenous pain or referred pain from myofascial trigger points.

Thermography complements the findings on electromyogram (EMG) and, in specific cases, may be the more diagnostically fruitful procedure. In Croft's (1989) review article on electrodiagnostic testing, he states the sensitivity for EMG is 60% to 80%, which is less than for TG (sensitivity 96%). EMG is helpful in ruling out motor radiculopathy, whereas TG is more beneficial in ruling out sensory/autonomic neuropathy. This author finds TG helpful in cases where the patient's subjective complaints and neurological exam suggest a sensory neuropathy, and EMG is more helpful in patients with motor nerve dysfunction.

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