

Thermography in Soft Tissue Trauma: Does It Have a Place?

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Several years ago I advocated the use of thermography in the evaluation of cervical acceleration/deceleration (CAD) trauma. Most of the research available in the early part of the 1980s favored thermography as a noninvasive method of evaluating a number of musculoskeletal disorders. More recently, in the evaluation of certain neuropathies, it was found to compare favorably, in terms of sensitivity and specificity, with CT, MRI, EMG and, in some cases, myelography.^{1,2} In the final analysis, however, thermography is generally found to be less specific than anatomical tests such as CT or MRI.^{3,4} Many proponents of thermography have been willing to accept its generally lower specificity on the grounds that it is relatively less expensive, noninvasive, safe, and easy. Some have argued that for certain conditions, such as reflex sympathetic dystrophy (RSD) and myofascitis, thermography offers the only objective means by which to evaluate them.

After sending many hundreds of patients out for thermography, I began to have serious questions about the sensitivity and specificity of thermography. "Recall that sensitivity is a measure of the amount of false negatives (high sensitivity = low false negatives) and specificity is a measure of the amount of false positive (high specificity = low false positive). A test can have high sensitivity and low specificity. Erythrocyte sedimentation rate is an example. It is elevated in dozens of conditions but is specific to none. The specificity of thermography is also significantly lower than its sensitivity.

I began to pour through the literature (medical and chiropractic) in search of the truth. This truth, unfortunately, is as elusive as the Holy Grail. The greatest difficulty lies in the interpretation of the results of what little true research has been done. The majority of these studies suffer from lack of blinding, a lack of control, poor outcome measure, small sample size or misinterpretation of their results. Most authors have addressed the issue of sensitivity and specificity but have made no mention of one measure of a test's worth which would be most meaningful to clinicians -- predictive value. Sensitivity and specificity are limited because they cannot answer two important questions: 1) If the test is abnormal (positive) how likely is it that the individual is diseased? 2) If the test is normal (negative), how likely is it that the individual is disease-free? Predictive value answers these questions.

The magnitude of this problem is illustrated by Hoffman et al.⁵ who analyzed all of the studies of thermography related to low back pain listed through MEDLINE between 1971 and 1990. From 81 relevant citations, 28 studies could be analyzed for diagnostic-accuracy data (sensitivity and specificity) and method. Diagnostic accuracy varied so significantly that meaningful interpretation was difficult. Twenty-seven of the 28 suffered from major methodological flaws and the only study which was of reasonably high quality found no discriminant value for liquid-crystal thermography. Most of the research in thermography has centered on the low back.

It is important to note that very little research on thermography has been done in our own profession despite the deluge of articles extolling its benefits. These latter authors often base their

opinions on assumptions that have not been proven and make statements like, "Clinical thermography is, however, the only reliable method for the detection and monitoring of sensory nerve root irritation, allowing us to document the cause of the pain." In truth, several studies have shown that thermography is not highly reliable for detecting this condition,^{3,4,6-8} and there are other ways of detecting sensory nerve root irritation, such as dermatomal somatosensory evoked potentials (DSSEP), which, incidentally, are also noninvasive and safe. Whether they are more reliable than thermography is not known.

Some authors state that thermography is "highly precise," alluding to the ability of most infrared units to discriminate fractions of degrees of temperature. While this level of precision is not arguable, this statement is somewhat misleading because the "interpretation" of temperature variations is much less precise. Questions regarding the exact meaning of variations in skin temperature continue to surface. Recently Bennett and Ochoa⁹ experimented with rats by creating a lesion in the sciatic nerves of one group. A control group had no lesion. Over subsequent days, a pattern characteristic of neuropathic pain developed (as expected) in the experimental group. Analysis by thermography revealed two curious things. Fully 59 percent of the nerve-lesioned rats had normal thermograms and, of the nerve lesioned group with thermographic abnormalities, the paw temperature varied from day to day between hot and cold.

This study raises several serious questions, I think: 1) If relatively serious nerve lesions cause thermographic abnormalities in rats only 41 percent of the time, how often would these thermographic abnormalities be present with less severe nerve trauma? And how would these findings relate to similar mild injuries or trauma seen in man? 2) If the temperature of the skin varied from hot to normal to cold on different days in the abnormal thermogram experimental group of rats, how likely is it that the same phenomenon might be present in humans in some instances? And, if this is the case, would we not need to obtain thermograms on several different days to have a clear picture of the true physiology? And, if it turns out that this is the case (no studies, that I am aware of, have tested this hypothesis in humans) how does this effect our current model of thermographic interpretation? Most authorities, for example, draw different conclusions for hot vs. cold findings. Perhaps it is as pointless to record a thermogram on a single occasion as it is to measure the ocean's tide on only one occasion.

Gerow et al.¹⁰ produced a complete sciatic lesion in rats and found a statistically significant thermographic abnormality. It is difficult to extrapolate this data to humans since complete lesions of the sciatic nerve are quite rare. Curiously though, the authors found a return to symmetry in 63 days, raising a question about the possible affect of time on obtaining meaningful and reliable information from thermography.

So What?

This article is not meant as a review of thermography. Space is too limited and such articles are legion. Nor is it intended as a requiem. However, thermography, in my opinion, stands at the virtual escarpment of oblivion. It has failed to weather the storm of critical research and has failed to successfully grab a niche in the management paradigm of soft tissue trauma. Other factors have also helped push it towards its destiny: unscientific and unsubstantiated claims made usually by non-physicians, poorly designed research, the medical-legal connection, and fear of malpractice claims, to name but a few. More and more these days, it seems that rather than the diagnostic nirvana which was promised to us by thermography pundits, all that we have is more questions.

This article is designed to ask the question "Where does thermography fit in?" For example, if a patient comes to us complaining of low back and leg pain (or neck and arm pain), and after some

period of treatment, fails to respond, we find ourselves at a common decision tree. Do we, a) send the patient out for an anatomical study such as CT or MRI, which might shed light on our patient's condition, b) send the patient for an electrodiagnostic test such as DSSEP or EMG, or c) send the patient for thermography? Consider the possible scenarios if we choose c: 1) The thermogram is normal. Given the inferior sensitivity and specificity of thermography to MR and CT, and in view of the high rate of malpractice claims arising out of disc herniation, do we feel comfortable continuing our care of this patient? If it turns out that this thermogram was a false negative and our patient later undergoes MRI which reveals a disc herniation, we may find ourselves in the rather unenviable position of explaining our logic in court. (Remember that the AMA's most recent position is that thermography is not useful as a diagnostic test.¹¹ On the other hand, since we are also concerned about the real diagnosis, shouldn't we, given a normal thermogram, order the MRI or CT now? If so, in retrospect then, the thermogram was an unnecessary procedure.

Now consider, 2) the original thermogram is abnormal. Knowing that the thermogram is less specific than MRI or CT, wouldn't we now turn to one of these tests to discover the exact location and nature of the lesion? That would constitute the standard of care in most communities. If so, in retrospect we might just as easily have skipped the thermogram and ordered the equally safe, equally noninvasive, somewhat more expensive, and significantly more sensitive and specific MRI. At least four case studies have been published in our literature which have advocated thermography in musculoskeletal disorders.¹²⁻¹⁵ In these instances, thermography was performed in conjunction with other diagnostic procedures (CT, MRI, etc.) and provided no unique or special insight into the patient's condition. The authors, however, felt that it was valuable.

Finally, thermography has been advocated as one of the only means of demonstrating myofascial trigger points (TP) and reflex sympathetic dystrophy (RSD).¹⁶⁻²⁰ In both instances, however, the diagnosis is made primarily on clinical grounds. First year chiropractic students generally have little difficulty in finding TPs. Presumably, a hands-on examination would not only yield more TPs than would thermography, but would allow categorization as to active vs. latent varieties. Ash et al.²¹ have found that irregular curved surfaces may result in artifacts of local increases of temperature virtually the same as those seen with thermography, which are said to represent TPs. The authors filled balloons with water heated to 26°C and discovered that, on thermography, there was a central area 1°C higher than that of the periphery. Whether this type of artifact occurs in clinical thermography is uncertain. In the case of RSD, careful examination will allow this diagnosis to be made in all but the earliest of cases. Since bone involvement is a common complication, serial x-ray and scintigraphy are the methods of choice in following the progress of the disorder. The usefulness of thermography as an adjunct to these procedures is questionable.

Based on the questions raised, I believe that further investigation of thermography will be necessary before we accept it within the management paradigm of soft tissue injury care. It does not, in my opinion, have an important role to play in the diagnostic framework.

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Editor's Note:

For more on personal injury, consult Dr. Croft's video, "Advances in Personal Injury Practice," #V-435, on the Preferred Reading and Viewing List, pages xx.

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