CRPS, RSD & Medical Thermography

CME Accredited Scientific Session
Hyatt Regency Hotel, Greenville, South Carolina April 30th,2011
South Carolina Society of Physical Medicine & Rehabilitation Scientific Session
South Carolina Medical Association Annual Meetings

Speakers

Marcos Leal Brioschi, MD, PhD

General Surgery, Forensic Sciences

Dr. Brioschi is the president of the Brazilian Thermology Society. He is also the Editor in Chief of The Journal of Pan American Medical Thermology.

Dr. Brioschi is a graduate in Surgery from Universidade Federal do Paraná in 1996 and received his master's in Medicine from Faculdade Evangélica do Paraná in 2000. He earned his PhD in Surgery from the Universidade Federal do Paranáin 2003. Dr. Brioschi is a Post-doctoral Faculty of Medicine at the Hospital and Clinics of the Universidade of Sao Paulo within the Department of Neurology. He has experience in Surgery, Forensic Medicine and Clinical Thermology (infrared imaging, thermography). He has special interest in the following subjects: pain management, breast cancer, angiology and surgery.

Kamayni Agarwal-Kozlowski, MD

Anesthesiology

Dr Agarwal-Kozlowski is Medical Director at the Center for Palliative Care and Pain Management, Hanseatic Care, in Hamburg, Germany. She has sub specialization in Pain Medicine, Emergency Medicine, Palliative Medicine, Traditional Chinese Medicine, Ayurveda, Neural Therapy and Psychosomatic Care. Dr. Agarwal-Kozlowski is a member of the German Association for Anesthesiology and intensive Care, the German Association for Palliative Medicine, the German chapter of the International Association for the Study of Pain (IASP) and the German Association for Acupuncture. She has utilized Medical Thermology for the past 16 years and has special interest in interventional pain management of neuropathic, sympathetically maintained and malignancy associated pain.

Robert G. Schwartz, MD

Physical Medicine & Rehabilitation

Dr. Schwartz owns and operates Piedmont Physical Medicine & Rehabilitation, PA, in Greenville, SC. Within his practice he specializes in pain diagnosis and treatment, physical medicine & rehabilitation, and peripheral vascular medicine.

Dr. Schwartz completed his undergraduate studies at the University of Michigan in Ann Arbor, Michigan, attended medical school at Wayne State University in Detroit, Michigan and completed his residency in Physical Medicine & Rehabilitation at the University of Texas Health Science Center in San Antonio, Texas. He is Board Certified Physical Medicine & Rehabilitation, Pain Management, Electro diagnostic Medicine, Orthopedic Medicine and Thermology. Dr. Schwartz is also a Fellow of the Society for Vascular Medicine and Biology. Dr. Schwartz is the President of the American Academy of Thermology, theExecutive Director for the South Carolina Society for Physical Medicine & Rehabilitation, and the Medical Director for Physical Medicine & Rehabilitation at Bon Secours St. Francis Hospital in Greenville, South Carolina.

Hisashi Usuki, MD, PhD.

Surgical Oncology

Dr. Usuki is the Director and Chief of the Japanese Association of Thermology. Dr. Usuki is a Clinical professor and the Director of the Surgical Center at Kagawa University Hospital in Kagawa, Japan. Dr. Usuki is a member of the International Society of Surgery, the Society of Medical Innovation and Technology, and on the Editorial Board for the journal Thermology International. His published areas of research include Thermographic examination of breast disease, surgical therapy for digestive cancer and postoperative quality of life, efficiency improvement of surgical care centers and thermal management of patients in operative rooms.

Ho-Yeol Zhang, MD, PhD

Neurosurgery

Dr. Zhang is a Clinical Professor of Neurosurgery at Yonsel University College of Medicine in Seoul, S.Korea and a Clinical Fellow in Neurosurgery at Yongdong Severence Hospital, Yonsei University College of Medicine .

Dr. Zhang completed his postdoctoral research in the Neurosurgery Spine Lab at Stanford University, California. He Chairs the Scientific Committee for the Korean Society of Thermology. Dr. Zhang also owns patents for the Cervical Artificial Disc,and Cervical Intervertebral Cage. Dr. Zhang has several Thermography related publications on topics including carpal tunnel syndrome, radiculopathy, lumbar degenerative disc disease, lumbar sympathectomy, discography in multiple HLD, whiplash, gastroesophogeal reflux, and airport security for travelers likely to commit crimes or be involved in narcotic abuse.

Srini Govindan, M.D.

Neurology, Sleep Medicine & Pain Management

Dr. Govindan is the Executive Director of the American Academy of Thermology. Dr. Govindan practices at Neuro-di agnostics/IDM in Wheeling, West Virginia His residency training in Neuropathology was from the in Neurology at the University of Maryland Medical Center in Baltimore,MD and completed his residency in Neurology at the West Virginia University Medical Center, Morgantown, WV.

He is Board Certified by the American Academy of Pain Management, The American Board of Forensic Medicine and the American Academy of Experts in Traumatic Stress. He is a Fellow of the American College of Angiology, The American Academy of Disability Evaluating Physicians, The American College of Forensic Examiners and The Fellow American Academy of Thermology.

Kurt F. Heitman, M.D.
Opthamology

Dr. Heitman is a graduate of the Univ. of Texas Southwestern Medical School in Dallas and completed his residency in Ophthalmology at the University of Texas Health Science Center at San Antonio, Texas. He is a Fellow of the American Academy of Ophthalmology. Dr. Heitman has been Chief of Surgery- 92nd Strategic Hosp. Fairchild AFB, WA, Chief of Dept. Ophthalmology- Greenville Hosp. System and President, South Carolina Society of Ophthalmology.

Dr. Heitman has been a pioneer in Somato Visceral involvement, especially involving diseases of the eye, in patients with RSD and Barre Lieou Syndromes. He has given several lectures on Ocular Manifestations of Reflex Sympathetic Dystrophy and is a Medical Advisor to the South Carolina Reflex Sympathetic Dystrophy Association.

Ashish G. Shanbhag, M.D.
Neuromusculoskeletal Medicine, Interventional Spine & Pain Management

Dr. Shanbhag is Board Certified in Physical Medicine & Rehabilitation. He went to medical school at the Medical University of South Carolina and completed his Residency training at the University of Minnesota and the University of Alabama.

Dr. Shanbhag is President of the Spartanburg County Medical Society and The South Carolina Society of Physical Medicine & Rehabilitation. He is the Executive Director South Carolina Society of Interventional Pain Physicians and is a Board Member South Carolina Medical Disciplinary Commission. He has been a Clinical Instructor in Physical Medicine & Rehabilitation at the Medical University of South Carolina, Department of Neurology – Division of Physical Medicine & Rehabilitation and at the University of Minnesota, Department of Physical Medicine & Rehabilitation, in Minneapolis, Minnesota.

Abstracts

GUIDELINES FOR NEURO MUSCULOSKELETAL THERMOGRAPHY
(SYMPATHETIC SKIN RESPONSE STUDIES)

General Statement:

This guideline was prepared by members of the American Academy Of Thermology (AAT) as a guide to aid the neuro-muscular thermologist and other interested parties. It implies a consensus of those substantially concerned with its scope and provisions. The AAT guideline may be revised or withdrawn at any time. The procedures of the AAT require that action be taken to reaffirm, revise or withdraw this guideline no later than three years from the date of publication. Suggestions for improvement of this guideline are welcome and should be sent to the executive director of the American Academy of Thermology. No part of this guideline may be reproduced in any form, in an electronic retrieval system or otherwise, without the prior written permission of the publisher.

Members of the committee: Robert G. Schwartz M.D. Chairman, Robert Elliott, M.D., Ph D., Gerald S. Goldberg, M .D., Srini Govindan, M.D., Timothy Conwell, D.C., Philip P. Hoekstra, III, Ph.D., David Pascoe, Ph D., Ram Purohit, D.V.M, Ph.D., Jim Waldsmith DVM, Richard T. Herrick, M.D.

Updated 2009

Extremity and Spine Infrared Sympathetic Skin Response (SSR) Evaluation

Purpose:

Infrared SSR studies of the extremities and spine are performed to provide an overview of the location, extent and severity of sympathetic skin response abnormalities. When abnormalities due to vasomotor/sudomotor dysfunction occur there are associated changes in skin galvanic impedance and skin temperature. Skin galvanic impedance changes map closely with skin temperature. In physics this is explained by the fractal nature of infrared waves and their relationship to resistance and conductivity. The SSR evaluation can be performed from the cranium to the base of the spine (inclusive of all segments) and torso to the extremities, extended to the fingers and toes.

Common Indications:

Some of the common indications for performance of extremity and spine infrared SSR imaging include (1-11):

- Evaluation or follow-up of patients with known or suspected vasomotor instability.
- Assessment of patients with known Reflex Sympathetic Dystrophy (RSD), Chronic Regional Pain Syndrome (CRPS) types I and II, Thoracic Outlet Syndrome, Vaso-motor Headache and Barre'-Leiou Syndrome.
- Pre-procedure assessment for planning of intervention.
- Follow-up to determine technical adequacy of surgical intervention, i.e., sympathetic block, sympathectomy and/or spinal cord stimulator placement.
- Follow-up to detect improvement, progression or spread of disease, which may reflect change in condition.
- Evaluation of vasospastic disorders, rheumatic inflammation and unexpected post operative or post fracture pain.
- Evaluation of trauma, shoulder hand syndrome or other disorders associated with autonomic dysfunction.
- Mapping of the extent of vasomotor instability to guide sympathetic response generator identification.
- Mapping of the location of vasomotor instability for impairment rating purposes.
- Confirmation of diagnostic inclusion criteria for clinical diagnostic purposes.
- Confirmation of diagnostic inclusion criteria for research purposes.

Contraindications and Limitations:

Contraindications for extremity and spinal infrared SSR imaging include the following:

- Presence of casts, bandages or other technical factors that preclude the ability to expose skin to a temperature equilibration environment.
- An uncooperative patient.

Guideline 1: Patient Communication and Preparation:

1.1 The examining physician explains why the extremity and spinal Infrared SSR examination is being performed to the patient, taking care to ensure that the patient understands the necessity for each aspect of he evaluation.

1.2 Responds to questions and concerns about any aspect of the examination.

1.3 Advises the patient about risk factors and symptoms of vasomotor instability or C Fiber (sympathetic) pain, and the benefits of movement in the presence of sympathetic pain or vasomotor instability.

1.4 Refers specific diagnostic, treatment or prognosis questions to the patient's physician.

1.5 Patient should not have contact with any object if that body part is being imaged. Cotton garments may be worn to cover breast or genital areas when they are not under study.

1.6 Shower or bathe the morning of the test to ensure that the skin is as clean as possible; however, avoid hot water exposure to the skin for at least two hours prior to the test.

1.7 Avoid placing any material of any kind on the skin, such as any skin lotions, deodorants, preparations, moisturizers, liniments, topical analgesics, etc. Avoid make-up if the face is to be examined

1.8 Wear loose clothing to the test; avoid anything binding against the skin; avoid support undergarments or pantyhose. Do not wear jewelry, including rings if the hands are to be examined.

1.9 Avoid skeletal manipulation, acupuncture, physical therapy, the use of TNS units, or electrodiagnostic testing for 12 hours prior to the test. Exceptions should be noted in the record.

1.10 Whenever possible steroids, sympathetic blockers, vasoactive medications, opiates and transdermal patches should be avoided for 24 hours prior to testing (8-16 hours minimum). Exceptions should always be recorded in the record.

1.11 When Stress examinations are being performed, medications that are not medically necessary and that alter sympathetic function should be avoided for at least 24 hours prior to testing.

1.12 In the absence of extenuating circumstances, for original diagnostic studies sympathetic and neurolytic blocks should be avoided for 3 days prior to testing (5,12,13,14).

Guideline 2: Patient Assessment

Patient assessment should be performed before infrared SSR imaging. This includes assessment of the patient's ability to tolerate the procedure and an evaluation of any contra-indications to the procedure (4,15).

2.1 Obtain a complete, pertinent history by interview and/or review of the patient's medical record. A pertinent history includes:

a. Current medical status, especially regarding pain and vasomotor instability.

b. Presence of any signs or symptoms of allodynia or hyperalgesia in association with sudomotor, vasomotor or other autonomic dysfunction.

c. Relevant risk factors for vasomotor instability: prior history of RSD or CRPS, trauma, fracture, repetitive use, vibration syndrome, peripheral neuropathy, spinal pathology, radiculopathy, vasomotor headache, rheumatic illness, cardiovascular disease, hypertension, diabetes, peripheral vascular disease, coagulopathy, birth control pill use, hypothyroidism or infection.

d. Pathology/Laboratory investigation values.

e. Current medication or therapies

f. Results of other SSR, thermographic or vascular studies

g. Results of prior autonomic, sympathetic or vascular interventions

2.2 Complete a limited, focused, detailed or extensive physical examination, which includes assessment of all structures under study. Trophic changes, vasomotor or sudomotor changes and possible pain generators should be documented.

Guideline 3: Examination Guidelines

3.1 Infrared thermography both measures and maps the degree and distribution of skin temperature changes. Skin temperature is largely under the control of the autonomic nervous system and bilateral symmetry is expected through out the body. Asymmetric patterns of 1 degree centigrade or greater (that are not due to local traumatic, inflammatory or vascular disease) occur when sympathetic pathology exists.

Thermography is not a test of structure, but rather physiology and therefore when structural injury is suspected other radiographic imaging or diagnostic studies should be performed. This is important as treating other previously undiagnosed conditions can often result in resolution of symptoms.

Due to the complex nature and etiology of painful conditions associated with skin temperature asymmetry patterns, only those doctors trained in the proper techniques required to perform and interpret SSR should do so. When present, the pattern of asymmetry discovered by infrared SSR examination should guide the treating physician in determining the source or generator of the abnormality. Both response to treatment and additional testing may still be required to complete this task (16-21).

3.2 All studies should utilize infrared technology with sensitivity of at least 0.1 degree centigrade (100 units nominal expansion thermal drift; NETD) and a minimum of 100 micro- radians spatial resolution.

3.3 All studies should be performed in a laboratory where ambient temperature is controlled, free from drafts and where there is no exposure to ultraviolet rays that may result in heating. The imaging room should be comfortably cool to allow for pull-off of superficial heat from the skin (20-25 degrees centigrade is commonly used). Unless a stress exam is intentionally being done no extraneous thermal stresses should exist.

3.4 Ventilation systems should be designed to avoid direct airflow onto the patient. Carpeted flooring is preferred. Exposing the patient's feet may assist with equilibration, even with upper extremity examinations. Standard fluorescent lights are appropriate.

3.5 While a single set of images can be adequate in cases where obvious thermal asymmetry exists, repetition at specified time intervals (usually fifteen minutes, but not to exceed twenty minutes) allows for assessment of reproducibility and progressive change with increased exposure to the ambient temperature. No equilibration period is required for post block or stress test examinations.

3.6 A standard exam protocol for each segment evaluated should be used. This will frequently require multiple infrared SSR windows with different points of focus (arm, forearm, wrist, hand, thigh, leg, foot, cervical, thoracic and lumbosacral spine). Each point of focus should include anterior, posterior, medial, lateral or oblique views. Contralateral and AP views should be equidistant and fill the image screen.

3.7 The patient's physical and mental status is assessed and monitored during the examination, with modifications made to the procedure plan according to changes in the patient's clinical status during the procedure. Also, findings are analyzed throughout the course of the examination to assure that sufficient data is provided to the physician to direct patient management and render a final diagnosis.

3.8 Appropriate infrared SSR instrumentation, which includes real time display, electronic static image capture, storage, post capture annotation or hard copy documentation capabilities.

3.9 Evaluate the patient's physical and mental status prior to discharge (22-27).

Guideline 4:
Review of The Infrared Thermography Examination

4.1 The data acquired during the extremity and spinal infrared SSR examination should be reviewed to ensure that a complete and comprehensive evaluation has been performed and documented. Any exceptions to the routine examination protocol (i.e., study omissions or revisions) should be noted and reasons given.

4.2 Record all technical findings required to complete the final interpretation so that the measurements can be classified according to the laboratory diagnostic criteria (these criteria may be based on either published or internally generated data, but must be internally validated regardless of the source). (see Appendix)

4.3 Complete required laboratory documentation of the study.

4.4 Alert medical director or other responsible physician when immediate medical attention is indicated, based on the infrared SSR examination findings.

Guideline 5: Presentation of Exam Findings

5.1 Provide preliminary results as provided for by internal policy based on examination findings.

5.2 Present the record of diagnostic images and when applicable, explanations for sub-optimal examination findings to the interpreting physician for use in diagnosis and archival purposes.

5.3 Alert laboratory medical director or appropriate health care provider when immediate medical attention is indicated.

Guideline 6: Exam Time Recommendations

High quality and accurate results are fundamental elements of the infrared SSR examination. A combination of direct and indirect exam components is the foundation for maximizing exam quality and accuracy.

6.1 Indirect exam components include pre-exam procedures:

a)obtaining previous exam data, completing pre-exam paperwork,

b)exam room and equipment preparation and

c)patient assessment, history, and positioning (Guideline 1 & 2).

6.2 Post exam procedures include:

a)clean up consisting of compiling, processing, and reviewing data for preliminary and/or formal interpretation (Guidelines 3 and 4),

B) patient communication (Guideline 2),

c)examination charge and billing activities where appropriate.

Recommended time: 30-40 minutes.

6.3 Direct exam components include equipment optimization, patient positioning throughout the exam, and the actual hands-on examination process. (Guideline 3)
Recommended time: 60 minutes.

Guideline 7: Continuing Professional Education

Certification is considered the standard of practice for infrared SSR technology. It indicates an individual's competence to perform medical technology at the entry level. After achieving certification, all Registered Infrared SSR Technologists are expected to keep current with:

7.1 Advances in diagnosis and treatment of sympathetic pain syndromes with and without vasomotor instability.

7.2 Changes in infrared SSR examination protocols or published laboratory diagnostic criteria.

7.3 Advances in SSR technology used for the extremity and spine examinations.

7.4 Advances in other technology used for extremity and spinal SSR examination.

Needs Assessment

Pre-existing vasomotor tone and vasomotor capacitance plays a significant role in thermoregulation, clinical symptomatology and manifestations of systemic illness.

Thermography is the only non-invasive technology available to image and map microcirculatory arterial-venous shunting (vasomotor instability) associated with these disorders. It can play an important role in clinical diagnosis and in distinguishing between central and peripheral etiologies of thermal change. Medical Thermography can also be used to document drug induced symptoms and paradoxical responses to blocks (8,16,23,27,28).

Other technologies like PET scan, MRI, Spectroscopy, Electrodiagnostics or EEG do not provide the same information offered by Medical Thermal imaging (18). The clinical application of Thermography can help physicians both understand the patho-physiology associated with these changes and improve patient outcomes (6,26,29,30).

The mission and bylaws of the American Academy of Thermology support the incorporation of thermal imaging into clinical medicine. The AAT recognizes a current and ongoing need to promulgate CME in the science and methods of thermal imaging and the clinical application of heat asymmetry patterns obtained from thermal imaging among both physicians and thermal technologists.

Appendix

It is recommended that published or internally generated diagnostic criteria should be validated for each thermography system used. When validating infrared SSR diagnostic criteria, it is important to realize that equipment, operator and interpretation variability is inherent to this process.

References

1) Friedman MS. The Use Of Thermography In Sympathetically Maintained Pain. Iowa Orthopaedic Journal 1994;14:141-7.

2) Pecina M M, Bojanic I. Overuse Injuries Of The Musculoskeletal System, New York: CRC Press, 1993. pgs 234,60,17,19,21,289.

3) Aronoff GM, Editor. Evaluation and Treatment Of Chronic Pain. Baltimore, Williams & Wilkins, 1998.

4) Merskey H, Bogduk N, Editors. Classification Of Chronic Pain: Descriptions Of Chronic Pain Syndromes And Definitions Of Pain Terms. Second Edition. Seattle, IASP Press, 1994.

5) Gulevich SJ, Conwell TD, Lane J, et al. Stress Infrared Telethermography is useful in the diagnosis of complex regional pain syndrome, type 1 (formerly reflex sympathetic dystrophy). Clinical Journal of Pain 1997;13:50-59

6) Gonzalez, E, Editor. The Nonsurgical Management of Acute Low Back Pain. Physiologic Assessment: Thermography, pgs 87-90, New York: Demos Vermande, 1997

7) Verdugo RJ, Ochoa JL: Use And Misuse Of Conventional Electrodi agnosis, Quantitative Sensory Testing, Thermography, And Nerve Blocks In the Evaluation Of Painful Neuropathic Syndromes. Muscle & Nerve 1993; 16:1056-1062.

8) Schwartz R. Electric Sympathetic Block: Current Theoretical Concepts And Clinical Results. Journal Of Back And Musculoskeletal Rehabilitation 1998; 10:31-46.

9) Pecina M, Krmpotic-Nemanic J, Markiewitz A. Tunnel Syndromes: Peripheral Nerve Compression Syndromes. New York: CRC Press, 2001. pgs 10,23,67,69,143,213,226,261.

10) Guide To The Evaluation Of Permanent Impairment, 6th Edition. Chicago: The American Medical Association, 2008.

11) Wallace D, Clauw, D, Editors. Fibromyalgia and other Central Pain Syndromes. NY, Williams & Wilkins, 2005

12) Policy Statement on Infrared Imaging. Arlington, American Chiropractic Association, 1999.

13) Clark, R.P. and De Calcina-Goff, M. Guidelines for Standardization in Medical Thermology Draft International Standard Proposals. Thermol. Osterr., 7, 47, 1997.

14) Togawa. T. and Saito, H. Non-Contact imaging of thermal properties of the skin. Physiol. Meas., 15,291, 1994.

15) Wilson PR, Stanton-Hicks M, Harden NR. CRPS: Current Diagnosis and Therapy. Seattle, IASP Press, 2005.

16) Lee M, Cohen, J. Editors. Rehabilitation Medicine and Thermography. New York University Medical Center. Wilsonville, Impress Publications, 2008

17) Hooshmand H, Hashmi M, Phillips EM. Infrared Thermal Imaging As A Tool In Pain Management-Part I. Thermology International 2001;11:53-65.

18) Hooshmand H, Hashmi M, Phillips EM. Infrared Thermal Imaging As A Tool In Pain Management-Part II. Thermology International 2001;11:117-30.

19) Wasner G, Schattschneider J, Baron R: Skin Temperature Side Differences -A Diagnostic Tool For CRPS. Pain 2002;98:19-26.

20) Uematsu S, Edwin DH, Jankel WR, et al: Quantification Of Thermal Assymetry: I. Normal Values And Reproducibility. J Neurosurg 69: 552, 1988.

21) Schwartz R. Resolving Complex Pain, Morrisville. LuLu Press, 2006

22) Overview Of Digital Infrared Thermal Imaging. Colorado Springs: American College Of Clinical Thermology. 2004.

23) Govindan S. Infrared Imaging Of Extracranial Microcirculation: A Review. Thermology International 2003;13:91-98.

24) Ammer, K. et al. Rationale for standardized capture and analysis of infrared thermal images. Proceedings Part II, EMBEC'02 2. European Medical & Biological Engineering Conference. Hutten, H. and Krosel, P. eds, IFMBE, Graz, 2002, p. 1608.

25) Ring, E.F.J. et al. Errors and artifacts in thermal imaging. Proceedings Part II, EMBEC'02 2, European Medical & Biological Engineering Conference. Hutten, H. and Krosel, P. eds, IFMBE, Graz, 2002, p. 1620.

26) Ammer K, Ring F. Standard Procedures for Infrared Imaging in Medicine. N.A Diakides (Ed) Infrared Imaging Section, Biomedical Engineering Handbook (3rd. Edition). London. CRC Press, 2006.

27) Mayr, H., Thür, H., Ammer, K. Electrical stimulation of the stellate ganglia. The Thermal Image in Medicine and biology, Ammer, K., and Ring, E.F.J., eds.,Uhlen-Verlag, Wien, 1995, p. 206.

28) Kruma E, Frettloh J, et al: Long-term skin temperature measurements - A practical diagnostic tool in complex regional pain syndrome. Pain 2008:8-22

39) Raj PP, Editor. Pain Medicine A Comprehensive Review. St. Louis: Mosby-Year Book Inc, 2003.

30) Orlandini G, Thermographic Changes After Surgery For Pain Syndromes. Thermology International 2002;12:43-50.

31) Sympathetic Skin Response Studies; Harvard Medical School's online medical text, July, 2007; www.wikidoc.org

INFRARED THERMOGRAPHY VASOMOTOR MAPPING FOR CRPS/RSD SYNDROMES

Robert G. Schwartz

Piedmont Physical Medicine & Rehabilitation, Greenville, SC

When performed with proper technique and under controlled conditions, medical Infrared Thermography is the test of choice for mapping of heat emission asymmetry patterns. The thermographically generated vasomotor map helps both with diagnosis of the underlying condition and provides invaluable information for therapeutic decision-making. The American Academy of Thermology 2009 Guidelines for Neuromusculoskeletal Thermography (Sympathetic Skin Response Studies) are attached to this abstract and will be reviewed.

From a thermographic perspective what is important is whether the resultant vasomotor response is great enough to create a change in skin temperature of greater then 1 degree centigrade compared to the contralateral side or with respect to the surrounding dermatome, sclerotome or vasotome. While dermatomes represent the distribution of sensory nerve fibers upon skin, a sclerotome reflects the distribution of skin galvanic impedance influenced by a visceral or non-visceral soft tissue structure. Numerous sclerotomal patterns exist.

Diffuse vasomotor instability involving an entire limb, or limb segment, not confined to a particular dermatome or sclerotome is the hallmark of true RSD. Dural, neuro-immuno-infectious interactions and multiple generators should be aggressively investigated. Sympathetic variants such as the Angry Back firing C syndrome where backfiring of the C fiber produces a localized increase heat asymmetry pattern (Ca+ dependant K+ channel mediated) and the Triple C Syndrome which produces a localized cold asymmetry pattern (fast K+ voltage gate driven) exist.

A combination of expertise in the basic physiology and anatomy of those structures that can exert influence in the distribution of the vasomotor abnormality found, the ability to objectify where heat emission asymmetry is actually occurring, and an understanding of what kind of variant exists allows for a more rational approach to intervention that is otherwise not possible.

References

1)Lee M, Cohen, J. Editors. Rehabilitation Medicine and Thermography. New York University Medical Center. Wilsonville, Impress Publications, 2008

2) Merskey H, Bogduk N, Editors. Classification Of Chronic Pain: Descriptions Of Chronic Pain Syndromes And Definitions Of Pain Terms. Second Edition. Seattle, IASP Press, 1994.

3)Schwartz R. Electric Sympathetic Block: Current Theoretical Concepts And Clinical Results. Journal Of Back And Musculoskeletal Rehabilitation 1998; 10:31-46.

4) Overview Of Digital Infrared Thermal Imaging. Colorado Springs: American College Of Clinical Thermology. 2004.

DIAGNOSIS AND MONITORING OF COMPLEX REGIONAL PAIN SYNDROMES (CRPS) WITH INFRARED THERMOGRAPHY. OVERVIEW OF CRPS/RSD DIAGNOSIS AND TREATMENT: THE AMERICAN ACADEMY OF THERMOLOGY GUIDELINES FOR NMSK THERMOLOGY

Kamayni Agarwal

Department of Anesthesiology, University Medical Hospital

Hamburg-Eppendorf; Germany

Complex Regional Pain Syndrome (CRPS) is a painful syndrome usually affecting distal extremities manifesting with a wide variety of symptoms. The most outstanding feature is unbearable pain including spontaneous pain, allodynia, hyperpathia, and hyperalgesia. Usually, the affected extremity displays changes in color and/or temperature (vasomotor disturbances), edema, alterations in transpiration, hair and nail growth (sudomotor disturbances), and muscular atrophy and/or dysfunction (mototrophic disturbances). Temperature variations are commonly considered as a major diagnostic criterion, hence infrared thermography can be utilized as a diagnostic tool with extraordinary sensitivity and repeatability. As with all physiologic studies this method does not provide exact specificity so it is still up to the physician to provide clinical correlation.

Pain in CRPS may not be initiated nor maintained by the somatic nervous system alone, which is normally involved in conveying information on damage to the organism, the autonomous nervous system is also involved. Skin temperature is a superior predictor of sympathetic activity as a good correlation is found between skin temperature and skin sympathetic nerve activity.

Surface temperature of an extremity reflects the result of a complex combination of central and local regulatory systems. Unfortunately, infrared thermography is rarely applied as a diagnostic tool although it may depict physiologic changes that cannot be demonstrated by ultrasound, CT or MR imaging. It is a non-invasive imaging technique that allows visualization of minor cutaneous temperature alterations. It is inevitable to establish standardized room conditions in order to produce repeatable as well as comparable thermograms, as inter- and intraindividual temperature may vary extremely.

SYMPATHOLYTIC TREATMENT IN ANESTHESIOLOGY FOR COMPLEX REGIONAL PAIN SYNDROMES (CRPS): PATIENT AND TRAINEE EDUCATION. Anesthesia Approaches And The Importance Of Outcome Measurement In CRPS/RSD And Other Sympathetic Pain Syndromes

Kamayni Agarwal

Department of Anesthesiology, University Medical Hospital Hamburg-Eppendorf; Germany

Determining pain intensity is a key intention in pain management. Unfortunately, no tool has been developed to date, that sufficiently fulfils this task, hence, it is extremely complex to conclude, if treatment offered to a patient is helpful or not. In neuropathic and sympathetically maintained pain, blocks to the sympathetic nervous system are performed in order to diminish pain intensity. They often result in dramatic relief, though, there is no way of proving, if improvement results from blocking other structures than the sympathetic nervous system, e.g. spinal nerves. As sympathetic fibers influence blood flow by varying size of vessels, a rise in the skin temperature is expected when performing sympathetic blocks, because variation of skin perfusion correlates with surface temperature. The configuration of changes in skin temperature provides us with precious information on the success of the intervention besides the patient's subjective impression.

Multiple methods have been described in treating patients with complex regional pain syndromes. The traditional therapeutic approach is a conservative one. Local anesthetic blockade of the stellate ganglion or the lumbar sympathetic chain are a widely accepted practice in the management of a variety of pain conditions. Due to anatomic hazards blocks of the thoracic sympathetic trunk are performed rarely. Effects of sympathicolysis in the management of CRPS are often distrusted as the role of the autonomous nervous system in producing and sustaining this syndrome are not clear yet.

To achieve a pain reduction of 50%, continuous block via a percutaneous catheter to the thoracic sympathetic chain had to be performed in average for 68.8 ± 80.2 hours (median 216 hours, range one to 400 hours) and for 104.0 ± 111.4 hours (median 246, range two to 599) to attain a score that would be appraised as "sufficient pain reduction" from the patients' point of view. Patients and physicians may become impatient and distrust the procedure, if clinical effects do not appear immediately. As a result, therapy is often discontinued. Here, infrared thermograms are essential to distinguish between ineffective sympathicolysis and improper technique. Latter is very important in training of medical students and residents. Also, posture and motor function may be monitored with this valuable tool.

THE ROLE OF INFRARED THERMOGRAPHIC IMAGING IN IDENTIFYING CRPS/RSD GENERATORS, RSD LOOK ALIKES, AND FORMULATING A RATIONAL TREATMENT APPROACH

Robert G. Schwartz

Piedmont Physical Medicine & Rehabilitation, Greenville, SC

Infrared thermographic vasomotor mapping defines the distribution of heat asymmetry and addresses the question of which body parts are involved in sympathetic pain syndromes. Dia- gnostic examples include RSD & its variants, Thoracic Outlet Syndrome (TOS), Cervical-Brachial Syndrome, Vasomotor headache, atypical facial pain, Barre-Leiou and Failed Back Syndrome.

While a sympathetic component should be considered in each of the aforementioned conditions, TOS deserves special attention. Patients who suffer from this malady often undergo extensive work ups only to find the results to be negative. X-ray examination for a cervical rib is only found in a minority of cases and when present an even smaller number of cases show positive arteriograms. Infrared imaging is uniquely suited to objectify the diagnosis of TOS.

There are several chronic regional pain syndromes that look like RSD but behave quite differently then true RSD. RSD Look Alikes and RSD variants will be reviewed. Points of differentiation will be discussed. A through knowledge of peripheral vascular and neuro-musculoskeltal disorders and how they can overlap in comorbid disease is fundamental to identifying RSD Look Alikes.

It is important to understand that treating any structure capable of generating a sympathetic response may actually correct the abnormality. Blocking above the vasomotor asymmetry followed by treatment below can be very effective. This may mean a local injection of medicine into a torn ligament that stops inflammation or repairs the underlying injury, or injection of a neurolytic agent that alleviates a persistent non-physiologic contraction of muscle. Naturally other examples exist, such as hyaluronidase injection into a knee, and oral or topical medications that restore blood flow and modulate sympathetic tone.

Through identification of the vasomotor map and variant presentation of the underlying condition, medical infrared imaging provides a unique diagnostic tool that is immensely instrumental in both diagnosis and treatment of associated painful conditions.

References

1) Schwartz R. Re-solving Complex Pain, Morrisville. LuLu Press, 2006

2) Wallace D, Clauw, D, Editors. Fibromyalgia and other Central Pain Syndromes. NY, Williams & Wilkins, 2005

3) Brioschi, M. Medical Thermology Textbook: Principles & Applications (Based Upon the international Consensus and Guidelines for Medical Thermography). Fortelaza, Brazil, 2010

HUMAN BEING SYMPATHETIC-STRESS LEVEL MONITORED BY IR REMOTE SENSING.

Brioschi ML, Matias EF, Colman D, Adratt E, Vargas JV, Yeng LT, Teixeira MJ.

Sao Paolo University Hospital - Neurology Department. Parana University Hospital Post-Graduation Department of Surgery. Brazilian Thermology Society. www.infraredmed.org

This paper described the use of non invasive remote passive IR imaging for measurement of human vital signs to detect altered autonomic physiological status, defined as physiological stress. By means of statistical signal processing, an automated system can detect levels of physiological stress, analyzing different human being sympathetic and parasympathetic functional variables such as breathing, supra-orbital artery pulse, cold nose, ears and hands, dry mouth, flushing and moving of the face. Breathing causes noticeable changes in temperature at the nasal area, which appear as periodic changes in the face IR image. The supra-orbital arteries of the face produce time-varying heat patterns which yield information about the cardiac cycle, called pulse. Ears, nose, hands vasoconstrictions and dry mouth diminish the IR radiation proportionally to the elevation of the stress level, contrary the hyper-radiation occasioned by the vasodilatation of the face. Results on human normal subjects and exposed during a television reality show were provided and validated against standard approaches for physiological parameters measuring. The proposed method has medical, traffic accident and public security applications as non-contact vital signs monitoring, driver's stress detection and intent identification at a distance. So it is ready to be used at airports, and health screening for monitor sympathetic-stress treatments, police departments, elder care, workplace preventive care, and vehicles dashboards.

Reference

1.Yamakoshi T, Yamakoshi K, Tanaka S, Nogawa M, Shibata M, Sawada Y, Rolfe P, Hirose Y. A preliminary study on driver's stress index using a new method based on differential skin temperature measurement. Conf Proc IEEE Eng Med Biol Soc. 2007;2007:722-5.

2.Yamakoshi T, Yamakoshi K, Tanaka S, Nogawa M, Park Sb, Shibata M, Sawada Y, Rolfe P, Hirose Y. Feasibility study on driver's stress detection from differential skin temperature measurement. Conf Proc IEEE Eng Med Biol Soc. 2008;2008:1076-9.

3. Schaefer AL, Jones SDM, Murray AC, Sather AP, Tong AKW. Infrared thermography of pigs with known genotypes for stress susceptibility in relation to pork quality. Canadian Journal of Animal Science 69:491-495, 1989.

4. Stewart M, Webster IR, Schaefer AL, Cook NJ, Scott SL. Infrared thermography as a non-invasive tool to study animal welfare. Animal Welfare 2005, 14:319-325.

5. Stewart M, Webster IR, Verkerk GA, Colyn JJ, Schaefer AL. Infrared thermography as a non-invasive measurement of stress in dairy cows. Journal of Animal Science 83, Suppl I: Abstract 633, 2005.

6. Cook NJ, Schaefer AL, Warren L, Burwash L, Anderson M, Baron V. Adrenocortical and metabolic responses to ACTH injections in horses: an assessment by salivary cortisol and infrared thermography of the eye. Canadian Society of Animal Science 81:621, 2001.

7. Pavlidis I, Levine J, Baukol P. Thermal imaging for anxiety detection. Proc. 2000 IEEE Workshop in Computer Vision Beyond the Visible Spectrum: Methods and Applications, Hilton Head Island, South Carolina, June 16, 2000, pp. 104-109.

8. Pavlidis I, Levine J. Monitoring of periorbital blood flow rate through thermal image analysis and its application to polygraph testing. Proceeding of the 23rd Annual International Conference of the IEEE Engineering in Medicine and Biology, Istanbul, Turkey, October 25-28, 2001.

9. Pavlidis I, Eberhardt NL, Levine J. Human behavior: Seeing through the face of deception. Nature, vol. 415, no. 6867, January 3, 2002.

10. Pavlidis I, Levine J. Thermal image analysis for polygraph testing. IEEE Engineering in Medicine and Biology Magazine, vol. 21, no. 6, pp. 56-64, November/December 2002.

11. Pavlidis I, Tsiamyrtzis P, Manohar C, Buddharaju P. Biometrics: face recognition in thermal infrared. Biomedical Engineering Handbook, N. Diakides, Ed. CRC Press, to appear in May 2005.

12. Garbey M, Sun N, Merla A, Pavlidis I. Contact-free measurement of cardiac pulse based on the analysis of thermal imagery. IEEE Trans. Biomed. Eng., 54(8):1418 - 1426, Aug. 2007.

13. Garbey M, Merla A, Pavlidis I. Estimation of blood flow speed and vessel location from thermal video. Proceedings of the 2004 IEEE Computer Society Conference on Computer Vision and Pattern Recognition, vol. 1, Washington D.C., June 27-July 2, 2004, pp. 356-363.

14. Garbey M, Sun N, Merla A, Pavlidis I. Contact-Free Measurement of Cardiac Pulse Based on the Analysis of Thermal Imagery. Technical Report Number UH-CS-04-08, December 14, 2004.

15. Chekmenev SY, Rara H, Farag AA. Non-contact, Wavelet-based Measurement of Vital Signs using Thermal Imaging. International Congress for global Science and Technology, ICGST, 2005 http://www.icgst.com/GVIP05/papers/P1150528101.pdf

16. Chekmenev SY, Farag AA, Essock EA. Multiresolution Approach for Non-Contact Measurements of Arterial Pulse using Thermal Imaging. Proceedings of the IEEE Computer Society Conference on Computer Vision and Pattern Recognition, page 129, NYC, NY, June 17 - 22, 2006. Http://mecca.spd.louisville.edu/ wwwcvip/research/publications/ 2006_2 /OTCBVS_2006.pdf

17. Murthy R, Pavlidis I, Tsiamyrtzis P. Touchless monitoring of breathing function. Proceedings of the 26th Annual International Conference IEEE Engineering in Medicine and Biology Society, San Fransisco, CA, September 1-5, 2004.

18. Murthy R. Feasibility study of breathing rate computation using infrared imaging, M.S. Thesis, Department of Computer Science, University of Houston, December 2004.

19. Murthy R, Pavlidis I. Non-Contact Monitoring of Breathing Function Using Infrared Imaging. Technical Report Number UH-CS-05-09, April 09, 2005. http://www.cs.uh.edu/docs/cosc/technical-reports/2005/05_09.pdf

20. Chekmenev SY, Farag AA, Essock EA. Thermal imaging of the superficial temporal artery: An arterial pulse recovery model. IEEE Workshop on Object Tracking and Classification in and Beyond the Visible Spectrum (OTCBVS'07), pages 1 - 6, Minneapolis, MN, June 22, 2007.

21.Sun N, Garbey M, Merla A, Pavlidis I. Imaging the cardiovascular pulse. Proceedings of the IEEE Computer Society Conference on Computer Vision and Pattern Recognition, volume 2, pages 416 - 421,San Diego, CA, June 20-25, 2005.

22. Sun N, Pavlidis I, Garbey M, Fei J. Harvesting the thermal cardiac pulse signal. International Conference on Medical Image Computing and Computer Assisted Intervention (MICCAI'06), volume 2, pages 569 - 576, Copenhagen, Denmark, Oct. 1 - 6, 2006.

23. Yang M, Liu Q, Turner T, Wu Y. Vital Sign Estimation from Passive Thermal Video. Proceedings of the IEEE Computer Society Conference on Computer Vision and Pattern Recognition, 2008. Http://www.eecs.northwestern .edu/~yingwu/papers/conference/2008/CVPR2008f_InfraRed_final.pdf

24. Nhan BR ,Chau T. Infrared thermal imaging as a physiological access pathway: a study of the baseline characteristics of facial skin temperatures. 2009 Physiol. Meas. 30 N23-N35.

AUTOMATED COMPUTER MEDICAL THERMOGRAPHIC DIAGNOSIS.

Brioschi ML, Matias JEF, Colman D, Adratt E, Vargas JV, Yeng LT, Teixeira MJ.

Sao Paolo University Hospital - Neurology Department. Parana University Hospital Post-Graduation Department of Surgery. Brazilian Thermology Society. www.infraredmed.org

In order to improve infrared (IR) imaging diagnosis, application of computer software to the quantitative analysis of IR images has been studied by some investigators for years. The utilization of merely temperature alarms is not satisfactory for accurate diagnosis, it's is necessary to work with thermal patterns tools, as example algorithms and fractals, to identify physiological abnormalities like fever and some diseases, adjusted with ambient and inner eye reference temperatures. The authors have developed an on-line IR image processing system with specialized algorithms to identify different diseases. Using a system of IR pattern recognition, digital geometry and signal processing was possible to create a diagnostic tool to increase the accuracy of risk analysis of breast cancer, diabetic foot ulcer, sympathetic mediated pain syndromes, fibromyalgia thermoregulatory disturbance, knee osteoarthritis, hand/wrist rheumatoid arthritis, sleep disturbance, fever, and physiologic stress parameters. All the results were achieved from a data bank of FLIR images from the authors along 10 years of practice. From the results obtained, the quantitative diagnosis method by a computer was found to be a significant method. The overall accuracy of a computer diagnosis may vary more or less by different diseases assignments. The present processing system is being improved by the data bank.

Reference

1.Vargas JVC, Brioschi ML, Dias FG, Parolin MB, Mulinari-Brenner FA, Ordonez JC, Colman D. Normalized methodology for medical infrared imaging. Infrared Physics & Technology, 52:42-47, 2009.

INFRARED 4IMAGING MONITORING (IRIM) OF NEUROVASCULAR REACTIVITY TO ASSESS THE CARDIOVASCULAR RISK.

Brioschi ML, Colman D, Adratt E, Matias JEF, Vargas JV, Yeng LT, Teixeira MJ.

Sao Paulo University Hospital. Brazilian Thermology Society. www.infraredmed.org

An impressive amount of evidence has suggested that vascular endothelium plays an important role in the control of vascular function and structure by the production of nitric oxide. Skin vascular response is believed to be primarily due to micro-vascular reactivity; however, it is also mediated by sympathetic neurovascular interactions. This autonomic neurovascular response is involved with endothelial- and sympathetic neuronal-nitric oxide synthase (eNOS and nNOS) activity. A dysfunctional endothelium is an early marker of the development of atherosclerotic changes and can also contribute to cardiovascular events. Infrared Imaging Monitoring (IRIM) of vascular reactivity is a non-invasive, operator-independent test based on changes in fingertip temperature during and after arm cuff occlusion. IRIM has been shown to correlate with the burden of subclinical coronary atherosclerosis in asymptomatic patients, measured by coronary artery calcium (CAC) and nuclear perfusion imaging. Tarján et al. (2005) which reported that in patients with chest pain, low fingertip temperature rebound was strongly associated with myocardial infarction. Vascular reactivity is a vital component of vascular function that enables the circulatory system to respond to physiologic and pharmacologic stimuli that require adjustments of blood flow and alterations of vessel tone and diameter. Vascular reactivity can be exhibited at both the macro-vascular and micro-vascular levels. "Macro-vascular" pertains to large, conduit arteries, and "micro-vascular" refers to small, resistance vessels. Micro-vascular reactivity causes reactive hyperemia, whereas macro-vascular reactivity (flow-mediated dilatation or FMD) results from reactive hyperemia. Both macro- and micro-vascular reactivity are governed by multiple physiologic (endothelium-dependent and -independent) regulatory mechanisms and are mediated by a number of biochemical agents, such as nitric oxide (NO), endothelium-derived hyperpolarizing factor (EDHF), prostaglandins, adenosine, bradykinin, histamine, and other vasoactive substances. It is believed that macro-vascular reactivity is predominantly mediated by endothelium-derived NO, whereas micro-vascular reactivity is only partially mediated by NO. Previous studies have demonstrated the relationship between impaired micro- and macro-vascular reactivity and atherosclerotic cardiovascular disease. Similarly, several studies have demonstrated strong correlations between endothelial-dependent and independent vascular dysfunction and cardiovascular risk factors. In this regard, vascular dysfunction may be seen as an important "integrative factor" of the inherent atherosclerotic risk of an individual, taking into account the cumulative effect of various risk and protective factors. In addition to risk assessment for prediction of outcomes, another important aspect of using vascular function is to evaluate response to therapies. Jzerman et al. (2003) have found that individuals at high risk of CAD exhibit impaired micro-vascular function in skin. Moreover, recent studies have shown that skin vascular reactivity was significantly improved after statin therapy. Neurovascular dysfunction measured by IRIM is associated with the extent of myocardial perfusion imaging (MPI) and strongly correlates with Framingham risk score and CAC independent of age, sex, and traditional cardiac risk factors and is superior to Framingham risk score for the prediction of significant CAC.

References

1.Ahmadi N, et al. Low fingertip temperature rebound measured by digital thermal monitoring strongly correlates with the presence and extent of coronary artery disease diagnosed by 64-slice multi-detector computed tomography. Int J Cardiovasc Imaging. 2009;25:725-738.

2. Ahmadi N, Usman N, Shim J, et al. Vascular dysfunction measured by fingertip thermal monitoring is associated with the extent of myocardial perfusion defect. J Nucl Cardiol. 2009;16:431-439.

3. Ahmadi N, Hajsadeghi F, Gul K, Vane J, Usman N, Flores F, Nasir K, Hecht H, Naghavi M, Budoff M (2008) Relations between digital thermal monitoring of vascular function, the Framingham risk score, and coronary artery calcium score. J Cardiovasc Comput Tomogr 2(6):382-388

4. Ahmadi N, Bevinal MA, Hajsadeghi F, Sarraf G, Tirunagaram S, Foster GP, Tsimikas S, Hecht H, Naghavi M, Budoff M (2008) Relationship of oxidized LDL biomarkers persistent vascular dysfunction measured by fingertip digital thermal monitoring and progression of coronary artery calcification. J Am Coll Cardiol.

5. Tarján J, Nagy L, Kovács I, Kovács E, Árvai F, Dobai F (2005) Flow mediated change of finger-tip-temperature in patients with high cardiovascular risk. Cardiol Hung 35:11-16 .

6. Jzerman RG I, De Jongh RT, Beijk MA, Van Weissenbruch MM, Delemarre-van de Waal HA, Serne EH CDS (2003) Individuals at increased coronary heart disease risk are characterized by an impaired microvascular function in skin. Eur J Clin Invest 33(7):536-542.

7. NL TarjánJ, Kovács I, Kovács E, Árvai F, Dobai F (2005) Flow mediated change of finger-tip-temperature in patients with high cardiovascular risk. Cardiol Hung 35:11-16.

8. Gul KM, Ahmadi N, Wang Z, Jamieson C, Nasir K, Metcalfe R, Hecht HS, Hartley CJ, Naghavi M (2009) Digital thermal monitoring of vascular function: a novel tool to improve cardiovascular risk assessment. Vasc Med 14(2):143-148.

9. Thoden J, Kenny G, Reardon F, Jette M, Livingstone S (1994) Disturbance of thermal homeostasis during post-exercise hyperthermia. Eur J Appl Physiol Occup Physiol 68(2):170-176.

10. Brioschi ML, Macedo JF, Macedo RAC. Skin thermometry: new concepts. J Vasc Bras 2(2):151-160, 2003

STATISTICAL RELIABILITY AND VASOMOTOR CONSIDERATIONS IN DEGENERATIVE SPINAL DISEASES

Ho-Yeol Zhang,

Department of Neurosurgery, National Health Insurance Corporation Ilsan Hospital, Yonsei University College of Medicine, South Korea

Diseases of spinal neurosurgery are degenerative spinal diseases, spinal cord tumors, spinal injuries. I am discussing about the statistical reliability and vasomotor considerations in various spinal diseases.

Firstly, in the degenerative spinal diseases, thermography can be used to detect the radiculopathy. Meticulous division with 110 sectors was done at the neck, upper trunk and arm. Normal reference values in each sector were collected from 50 healthy controls. In the basis of this normal reference data, normal distribution curves of each thermal difference between the each opposite site sectors. After this, abnormal thermal difference between both opposite sector was calculated by the 99% confidence interval (i.e., $p<0.01$). Comparison with this thermal difference distribution curve and the temperature data of 110 sectors from each HCD (herniated cervical disc) patient's collection with unilateral protrusion was done. Cervical thermatomes of C4, C5, C6, C7 and C8 were calculated by these serial statistical analyses. Same procedure on the back and lower extremities were done and made the results of minimal abnormal thermal differences in each opposite sectors in the lower extremities and L4, L5 and S1 thermatome were made.

In the herniated lumbar disc (HLD) disease, the thermal asymmetry of the lower extremities means the amount of pain or the severity of disc protrusion and the inverse proportion of the symptom duration. And also thermography can be used to the operative indicator of chemonucleolysis of HLD.

Secondly, in the spinal cord tumors, the roles of thermography are the detections of many neurologically specific finding. Ipsilateral hypothermia in the motor weakness side can be found in the Brown-Sequard syndrome. Leveling of lesion in paraparetic or quadriparetic patient is possible in many cases. Thermatomal hypothermia in the nerve root tumor (schwannoma) can be found. Differential diagnosis between the cauda equina tumor and conus medullaris tumor can be done by thermography.

Thirdly, in the whiplash injuries, thermography can be used to the immediate diagnosis, recovery evaluation and differential diagnosis between whiplash injury and HCD.

In conclusion, these results which was based on the meticulous statistical analysis of the thermographic data with checking the temperature in the region of interest (ROI), can use in the clinics for the diagnosis, therapeutic effect and the decision of prognosis.

THE FIBROMYALGIA SYNDROME: THERMOGRAPHIC SCORE.

BrioschI ML, Yeng LT, Kaziyama HHS, Pastor EMH, Heupa S, Silva FMRM, Teixeira MJ.
Sao Paulo University Hospital. Brazilian Thermology Society.
www.infraredmed.org

Fibromyalgia syndrome (FMS) diagnosis, characterized by chronic widespread musculoskeletal pain, disturbed sleep, fatigue, depressive mood, anxiety, is eminently clinical and depends cautious evaluation. Two hundred and twenty and six patients with FMS and a group of 34 normal volunteers proceeding from the Clinic of Pain of the Division of Neurological Clinic of the Clinics Hospital of the College of Medicine of Sao Paolo University (HC-FMUSP) and of the particular doctor's offices examiners, had been selected according to American College of Rheumatology (ACR) criteria and evaluated later by infrared (IR) thermography. It was possible to create by the thermal distribution an agreement classification on the basis of cutaneous characteristics with visual inspection of the thermograms of 7 different regions: postero-inferior (G), antero-superior (A), lumbar (L), antero-inferior (P), face (F), postero-superior (C) and palmar (M). The test of multiple linear regression demonstrated that all the regions had correlated in the evaluation of the thermal alterations. Each region of interest (ROI) presented 2-4 typical characteristics, as the disposal and extension of the thermal alterations, that had been structuralized in the form of one prop up by means of multiple regression to predict the FMS presence ($R2=0,94$). The hyper-radiating image in complete or not "mantle form" and paravertebral associated with hypo-radiation of extremities resulted in a FMS thermographic impression. It had significant difference of the standard of cutaneous thermal distribution between all patients with FM and normal controls. Being that it was possible to classify them by means of IR imaging and to establish quantification criteria of the presence or not of the illness. Being overcome for base the clinical criteria of the ACR for fibromyalgia syndrome the clinical correlation with infrared imaging was possible and demonstration of one prop up thermographic diagnosis.

Reference

1.Brioschi ML, Yeng LT, Kaziyama HHS, Pastor EMH, Heupa S, Silva FMRM, Teixeira MJ. Documentação médico-legal da síndrome fibromiálgica: índice termográfico. Revista Dor (São Paulo) 9:1327-1344, 2008.

THE ROLE OF THERMAL IMAGING IN BREAST ONCOLOGY AND OTHER SURGICAL PATIENTS.

Hisashi Usuki, Norikatsu Maeda, Hironobu Sutou, Minoru Ohshima, Hirotaka Kashiwagi, Naoki Yamamoto, Shintarou Akamoto, Masao Fujiwara, Keitarou Kakinoki, Takehiro Takama, Masanobu Hagiike, Keiichi Okano, Yasuyuki Suzuki

The Department of Gastroenterological Surgery, Kagawa University, Japan

(A) Introduction. Thermography is a functional examination method. It has many different characteristics from other morphological examination methods. Researchers of thermal imaging were interested in such characteristics, which other examina tion methods did not have. In the results many important facts were detected for thermographic science. But, the all important discoveries for the thermological studies were not necessarily essential for the studies of each disease. They might not be useful for diagnosing or treatment of diseases. A diagnostic result, which was recognized by thermography, might be detected more accurately by other examination methods. Moreover, the medical science is developing continuously, and the requests for the treatment of each disease are changing all the time. In this presentation I will enumerate the characteristics of thermographic examination and discuss about which characteristics are important for the treatment of breast diseases and for the patients undergoing surgical treatment.

(B) Surgical Patients:In my previous study it was reported that the body temperature of the patients undergoing laparoscopic surgery had the hypothermia in comparison with the open surgery. The temperature of the patients with laparoscopic colectomy at the middle point of surgical period was 35.8±0.5 degree centigrade. This tended to be lower than the patients with open surgery (36.4±0.5).

The temperature of abdominal wall was also decreased from the beginning of pneumoperitoneum. In the typical case the lowest point of the abdominal wall temperature was ten minutes later than the tube temperature. In the next ten minutes, the body temperature became lowest.

It was reported that the risk of surgical site infection was related to the peri-surgical hypothermia. The body temperature can be measured without using thermographic instrument. But, the temperature of abdominal wall in a surgical period can be measured only by thermographic instrument which is non-touched measuring instrument. Then, it is necessary for demonstrating the usefulness of thermographic examination to certificate the relationship between the intra-operative hypothermia of abdominal wall and the post-operative infection of abdominal wall.

(C) Breast oncology. There are many unique characteristics of thermography in the diagnosis and the treatment of breast diseases. Thermography can detect non-palpable breast cancers. It can detect the breast carcinomas, which is not detectable by other morphological examination methods. It is able to forecast the carcinogenesis. Then, it may be useful for the mass screening of breast.

The thermographic findings relate to the prognosis of breast cancer patients. They have close relationship with its progress stage. They are also related to the proliferating ability of breast cancers. Then, it may be useful for foreseeing the prognosis of the patients.

Thermal abnormality of tumor covering skin is related to the dilatation of the subcutaneous vessels. It seems to be influenced by the producing ability of chemical mediator in the tumors. The findings of nipple hyperthermia are related to the distance from tumor to nipple. Then, it may be useful for determination of surgical method for each breast cancer patient.

However, the diagnostic accuracy of thermography can not surpass that of ultrasonography for breast diseases. There are many non-palpable breast cancers with micro-calcifications which were detected only by mammography. There are many reports "magnetic resonance imaging (MR)" are used for determination of the resecting line in breast preserving surgery. Then, the researchers should decide which way of thermographic usage could do what other examination methods could not do, and they should concentrate their effort to such study fields.

A RANDOMIZED SINGLE-BLINDED PLACEBO-CONTROLLED CLINICAL TRIALFOR ASSESSING EFFECTS OF ACUPUNCTURE AT HEGU (LI4) BY CONTACT FREE INFRARED THERMOGRAPHY

Kamayni Agarwal
Department of Anesthesiology, University Medical Hospital
Hamburg- Eppendorf; Germany

Even though evidence of its effects is tentative, acupuncture has long been used in the treatment of multiple maladies. So far, it has not been possible to discriminate the effects of the venue from specific results of needling itself, thus physicians merely depend on patients' statements. We investigated the efficacy of infrared thermography in distinguishing response to "true" acupuncture as compared to non-acupoint cutaneous and muscular needling ("sham" or "minimal" acupuncture) as well as without manipulation.

Thermographic imaging was performed in 50 healthy volunteers randomly assigned to four groups: acupuncture of hegu (LI 4), needling of a cutaneous and a muscular point where no acupuncture point has been described yet, and without manipulation. In a cross-over-protocol each proband completed all four arms of the protocol in a random order. Infrared thermograms were gathered at defined points in each group. The study protocol was approved by the ethics review board.

A significant increase in surface temperature occurred within 2 minutes after needling the acupuncture point hegu (from 30.1 ± 2.7°C to 31.2 ± 3.0°C and to 31.9 ± 2.5°C after 10 minutes, $p < 0.001$), whereas needling of the cutaneous, muscular as well as without any manipulation resulted in a decrease of temperature in the monitored area. Contact free infrared thermographic imaging is a reliable and easy to handle tool to distinguish between needling at hegu and needling of a non-acupoint ("sham" acupuncture).

OCULAR MANIFESTATIONS OF REFLEX SYMPATHETIC DYSTROPHY

Heitman, KF
Greenville, SC

Reflex sympathetic dystrophy (RSD), otherwise known as complex regional pain syndrome, is characterized by a history of trauma or disease, presence of persistent pain described by burning, throbbing or aching, presence of a vasomotor/ pseudo- motor disturbance, trophic changes of skin, muscle or bone, sensitivity to cold and/or edema, and relief with regional sympathetic blockade. Since the eye and its adnexa are richly innervated by the sympathetic nervous system, it is reasonable to expect RSD symptoms in these areas. Horner's syndrome and Barre Lieou syndrome, both of which consist of sympathetic dysfunction that involves the eye and ocular adnexa can help us understand and anticipate eye findings with RSD. Asha (1999) describes a patient with the optic-spinal phenotype of multiple sclerosis who developed syringomyelia with resultant RSD. This patient developed sympathetic dysfunction including Horner's syndrome and RSD of the hand. Kapoor (2002) describes a patient with RSD and associated visual sensorimotor findings. Morimoto (1997) describes a patient with chronic ocular pain after retina surgery that was diagnosed as RSD. Schwartz (2006) describes sympathetic dysfunction found in Barre Lieou syndrome, one subset of which involves ocular symptoms. There is plenty of evidence to suggest that RSD can be accompanied by ocular findings which will be described in this paper.

References:

1. Asha D, et. al. Syringomyelia and Complex Regional Pain Syndrome as Complications of Multiple Sclerosis. Arch Neurol. 1999;56:1021-1024.

2. Kapoor N, et. al. Complex regional pain syndrome type I: associated visual sensorimotor case findings. Clin J Pain. 2002 Mar-Apr;18(2):93-8.

3. Morimoto Y, et. al. A case of reflex sympathetic dystrophy following a retinous surgery. Masui. 1997 Apr;46(4):549-51.

4.Schwartz R. Resolving Complex Pain. Lulu Press, 2006