International Consensus and Guidelines on Medical Thermography 2011 (ICGMT 2011)
2nd International Work Group for Medical Thermography Meeting (IWGMT 2011)

Iguassu Falls, Paraná (Brazil) – November, 23th – 25th, 2011

IWGMT HONORARY PRESIDENT

Prof. Edward Francis John Ring

ICGMT HONORARY PRESIDENT

Prof Dr Manoel Jacobsen Teixeira

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Edmar Santos
Prof. James Mercer
Timothy D. Conwell

Local Committee

Giovanna Abreu Franco
Luciane Fachin Balbinot
Edmar Santos

PROGRAMME

Wednesday, November 23th

8-12h

- **FEVER / METABOLISM** SECTION
- **PAIN CLINIC** SECTION
- Thermoguided acupuncture 'How I Do It' (practice)
- Thermoguided mesotheraphy 'How I Do It' (practice)

13:30-18h

- **BREAST CANCER / ONCOLOGY** SECTION
- **VASCULAR** SECTION
- Endothelial dysfunction (braquial test) 'How I Do It' (practice)

20h Special welcome dinner

Thursday, November 24th

8-12h

- **NEUROSURGERY** SECTION
- **PAIN CLINIC** SECTION
- Thermoguided physiotherapy 'How I Do It' (practice)

13:30-15:30h

- **LEGAL MEDICINE / EXPERT** SECTION
- Thermoguided expert legal exam 'How I Do It' (practice)

15:30-18h
OFFICIAL CONSENSUS 2011 CEREMONY, SOBRATERM AND IWGMT,
Thermology and thermography medical speciality

Magna´s Conference: The Development of Quantitative Medical Thermography from Analogue to Digital – Prof Francis Ring (UK)

1. Associação Brasileira de Medicina Legal – ANTÔNIO BATISTA DE QUEIROZ
2. Associação Brasileira de Medicina Legal – FRANCISCO MORAES SILVA
3. Sociedade de Perícias Médicas – JARBAS SIMAS
4. Sociedade Brasileira para Estudo da Dor – LIN TCHIA YENG
5. Hospital de Clínicas da Faculdade de Medicina da USP – MANOEL JACOBSEN TEIXEIRA
6. Sociedade Brasileira de Termologia – MARCOS BRIOSCHI

Friday, November 25th

8-12h
- **DERMATOLOGY / ENDOCRINOLOGY** SECTION
- **VASCULAR** SECTION
- CRPS thermographic evaluation 'How I Do It' (practice)

13:30-18h
- **PAIN CLINIC** SECTION
- **AWARD** SECTION

* everyday from 12:00 to 13:30h will have thermography workshop at the sponsors stands and posters presentations.

Saturday, November 26th

Tour schedule – Bird Park / Iguassu Falls / Itaipu Binacional Generator

FEVER / METABOLISM

1. Measurement and evaluation of body temperature: Implications for clinical practice –Martha Sund-Levander (SWE)
2. New standards for infrared thermal imaging and applications for fever detection - Francis Ring (UK)
3. Time for a change when assessing and evaluating body temperature in clinical practice – Martha Sund-Levander (SWE)
4. Experiences with thermography in a clinical setting - James Mercer (NOR)
5. Direct calorimetry by infrared thermography – Antonio Cláudio Goulart Duarte (BRA)

PAIN & REHABILITATION (1)

1. The utilization of functional infrared imaging (fIR) in evaluating patients with presumptive complex regional pain syndrome (CRPS) - Timothy Conwell (USA)
2. CRPS diagnosis & Interventional pain management with Infrared Imaging – Kamayni Agarwal(GER)
3. Sao Paulo University Hospital thermography protocol for headache– Juliana Badaró (BRA)
4. Fibromyalgia: Evaluation by thermology – Kátia Nakamura (BRA)
5. Kinesiologic thermoguided evaluation by analytical myomodulation – Rose Miranda (BRA)

PAIN & REHABILITATION (2)

1. Thermographic imaging of effects during acupuncture – Kamayni Agarwal (GER)
2. Acupuntura termoguiada – Marcos Leal Brioschi (BRA)
3. Thermographic and clinical correlation of myofascial trigger points in the masticatory muscles – Denise Sabbagh Haddad (BRA)

4. The infrared (IR) in tissue repair process and its radiator biomaterials applied in dentistry - Francisco José Correa Braga (BRA)

5. A single-center, prospective, controlled, double blind and randomized study for evaluation of the efficacy and safety of Invel® active glove with Invel® technology -Joaci Araujo (BRA)

6. A controlled, doube blind and randomized study for evaluation of the efficacy and safety of Invel® active shirt with Invel® technology - Joaci Araujo (BRA)

7. Sao Paulo University Hospital thermography protocol for facet syndrome - Mônica Yasmin Pinto (BRA)

8. Mesoterapia termoguiada – Luciane Balbinot (BRA)

9.Application of infrared thermography in studies of acupuncture-moxibustion and meridians-Dong Zhang (CHI)

BREAST / ONCOLOGY

1. Aromatização e tumor de mama (fenômenos vasculares) - Henry OkigamI(BRA)

2. Avaliação termográfica da radioterapia de tumores de mama – Railda Shesea Taveira Rocha Do Nascimento (BRA)

3. Digital infrared thermal imaging (DITI) for breast screening - Kenneth Taylor (EL SALVADOR)

4. Câncer de mama e próstata na visão da medicina regenerativa – Paul Ling Tai (USA)

5. Thermographic examination for breast diseases – Hisashi Usuki (JAP)

6. 2011 Update on Breast IR Protocol – William Cockburn (USA)

7. Rastreamento termográfico de risco de câncer de mama - projeto Brasil - Marcos Leal Brioschi (BRA)

8. Sao Paulo University Hospital thermography protocol for breast cancer – Giovanna Franco (BRA)

VASCULAR (1)

1. Thermography and colour duplex ultrasound assessments of arterio-venous fistula function in renal patients – John Allen (UK)

2. Early detection of diabetic foot ulcerations – Manish Bharara (USA)

3. Sao Paulo University Hospital thermography protocol for varices – Roberta Miranda Soares (BRA)

4. Sao Paulo University Hospital thermography protocol for diabetic neuropathy – Luciane Fachin Balbinot (BRA)

VASCULAR (2)

1. Development of a clinical vascular optics measurement facility – John Allen (UK)

2. Can dynamic infrared thermography (DIRT) be useful in free perforator flap surgery? - James Mercer (NOR)

3. Functional infrared imaging in the diagnosis of Raynaud's Phenomenon & Advanced modelling – Archangelo Merla (ITA)

4. Systemic inflammation/local inflammatory activity, elevated plaque temperature (thermography) – Konstantinos Toutouzas (GRE)

5. Monitoring Renal Dialysis Patients by Hand Thermography - Francis Ring (UK)

6. Sao Paulo University Hospital thermography protocol for endothelial dysfunction – Edmar Santos (BRA)

NEUROSURGERY

1. Organização e implantação de um serviço de dor: constituição da equipe e recursos materiais – Manoel Jacobsen Teixeira (BRA)

2. Dor e fenômenos vasculares – Manoel Jacobsen Teixeira (BRA)

3. Usefulness of thermography in evaluation of patients with FBSS following radiofrequency dorsal root ganglion lesioning – Jung Yul Park (KOR)

4. Role of intraoperative infrared thermography for prediction of successful percutaneous radiofrequency sympathectomy for palmar hyperhidrosis – Jung Yul Park (KOR)

5. Thermatomal Alteration in Cervical Disc Hernia/ HerniationC5,C6: Case Report and Literature Review – Kátia Nakamura (BRA)

LEGAL MEDICINE / EXPERT

1. Thermal infrared imaging in neuropsychophysiology: new approaches and possibilities – Archangelo Merla (ITA)
2. Termografia pericial sistêmica preditiva - Francisco Moraes Silva (BRA)
3. Departamento de termografia pericial da ABML – Marcos Leal Brioschi (BRA)
4. Termografia pericial – Daniel Colman (BRA)
5. Thermal symmetry of the limbs in healthy subjects – Ricardo Vardasca (POR)
6. Atlas of diagnostic thermography: full body positioning - Viviane Oliveira (BRA)
7. Atlas of diagnostic thermography: anatomic correlation - Gladis Reisemberger (BRA)
8. The usage of medical thermography as a complementary examination for occupational conditions affecting the upper limbs – Ricardo Vardasca (POR)
9. Work-Related Musculoskeletal Disorders – Lin Tchia Yeng (BRA)
10. Experiência do uso da toxina botulínica no tratamento da dor miofascial – Lin Tchia Yeng (BRA)

DERMATOLOGY / ENDOCRINOLOGY

1. Thermographic evaluation of patch tests: the two patterns – Luigi Laino (ITA)
2. Epidermal skin precancerous and cancer lesions and video-thermography: the hypothesis of skin field cancerization – Luigi Laino (ITA)
3. Telethermography assisted by "Thermal stimulation" method – Aldo Di Carlo (ITA)
4. An exploratory look at the thermal characteristics of the eyes in patients with thyroid eye disease – John Allen (UK)
5. Thermography, food allergy, fibromyalgia and Enviromental Medicine - gilberto De Paula (BRA)

POSTERS

1. Evaluation of three thermal imagers for skin temperature measurement using the Land P80P blackbody source and a spatial resolution test object - John Allen (UK)
2. Correlations between quantitative sensory test and infrared thermography in low back pain patients - Joaci Araujo (BRA)
3. Use of thermal imaging in the diagnosis of repetitive strain injury - Daniela Akemi Itakura (BRA)
4. Application of infrared imaging technology in pressure ulcers - Daniela Akemi Itakura (BRA)
5. Protocolo de termografia HCFMUSP: Sacroileíte – Adolfo Marcondes Amaral Neto (BRA)
6. Protocolo de termografia HCFMUSP: Síndrome Complexa de Dor Regional (cold stress tes) – Fabio Prieto (BRA)
7. Protocolo de termografia HCFMUSP: Alergia alimentar (teste provocativo) – Geraldo Henrique Mascarenhas Da Silva (BRA)
8. Protocolo de termografia HCFMUSP: Distúrbio do sono – Joaquim Ricardo Cangue (BRA)
9. Protocolo de termografia HCFMUSP: Síndrome do túnel do carpo – Paulo Alves De Freitas (BRA)
10. Protocolo de termografia HCFMUSP: Tireóide – Tânia Maria Möller Bastos (BRA)
11. Protocolo de termografia HCFMUSP: Síndrome fibromiálgica – Tatiana Tourinho (BRA)
12. Protocolo de termografia HCFMUSP: Risco AVC (carótidas) – Gerson Araújo Lima (BRA)
13. Protocolo de termografia HCFMUSP: Insuficiência arterial periférica de MMII – José Haddad júnior (BRA)
14. Protocolo de termografia HCFMUSP: Mamas – Mauricio Zylbergeld (BRA)
15. Protocolo de termografia HCFMUSP: Pubalgia – Mônica Lourdes Andrade Lima (BRA)
16. Protocolo de termografia HCFMUSP: Tendinites de membros superiores – Roberto Menezes Bezerra Dias (BRA)
17. Protocolo de termografia HCFMUSP: Joelhos – Wellington Luis Fagundes Braun (BRA)
18. Protocolo de termografia HCFMUSP: Gordura marrom – Antonio Alfonso Pacileo Cruz (BRA)

Abstracts

FEVER / METABOLISM

TIME FOR A CHANGE WHEN ASSESSING AND EVALUATING BODY TEMPERATURE IN CLINICAL PRACTICE

Martha Sund-Levander. RNT, ICN, PhD

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Evaluation of body temperature is one of the oldest known diagnostic methods and still is an important sign of health and disease, both in everyday life and in medical care. In clinical practice, assessment and evaluation of body temperature has great impact on decisions in nursing care as well as medical diagnosis, treatment and the laboratory test ordered.

The definition of normal body temperature as 37° C and fever as > 38° C still is considered the norm world- wide, but in practice there is a widespread confusion of the evaluation of body temperature. In addition, tradition and culture seems to have a great impact on what is considered fever and necessary actions. When assessing body temperature, we have to consider several "errors", such as the influence of normal thermoregulation, gender, ageing and site of measurement. Actually, there is a lack of evidence for normal body temperature as 37°C, due to inter- and intra individual variability. In addition, as normal body temperature shows individual variations, it is reasonable that the same should hold true for the febrile range. By tradition, the oral and axillary readings are adjusted to the rectal temperature by adding 0.3°C and 0.5°C, respectively. However, there is no evidence for adjusting one site to another, i.e. no factor does exist which allows accurate conversion of temperatures recorded at one site to estimate the temperature at another site.

Morbidity and mortality in infectious diseases, and difficulty to discover signs and symptoms of ongoing infection early on in multi-diseased elderly is a well known problem in clinical practice. As there is a lack of specific symptoms in the presentation of infection in this group, the presence of fever becomes most important. However, as normal (baseline) body temperature in frail elderly maybe low, the degree of fever also may be below 38°C.

Taken together, it is time for a change when assessing and evaluating body temperature in clinical practice.

DIRECT CALORIMETRY BY INFRARED THERMOGRAPHY

Antonio Cláudio Goulart Duarte[1,2], Marcos Brioschi[2], Manoel Jacobsen Teixeira[2]

1. Doctor, Nutrologist, Professor at Medicine Faculty of Rio de Janeiro Federal University,
2. Clinical Thermology and Thermography Pos Graduate Specialty - Hospital das Clínicas - School of Medicine - University of São Paulo

INTRODUCTION: Every human metabolic process depends essentially on oxygen utilization for heat production. Cutaneous emitted infrared energy is the most important one. Direct and indirect evaluation between the relationship of energy intake (absorption) from food consumption and energy loss (emission) confirm the energy conservation law and establish calorimetry value. They have equivalent final results but are laborious, expensive and not practical, so evaluation of direct calorimetry by cutaneous emitted infrared thermography may be less expensive, accurate, and practical. This one checks the value and distribution of body temperature, which are under neuronal vegetative nervous system control, becoming a no invasive, painless, easy and cheap method contributing for better metabolic diagnosis and therapeutic.

OBJECTIVE: Evaluation of direct calorimetry using cutaneous emitted infrared energy thermography in adults.

METHOD: Before the exam: a) Fast for 10-12 hours; b) No smoking, alcohol, coffee, tea, or mate; c) no tight clothes, elastic stocking, rings, jewels, or other objects; d) take a shower avoiding warm water in the last 2 hours; e) no products over the skin (lotions, creams, pastes, deodorants, adhesive medications); f) use the same dietary plan the day before the exam; g) not avoid eating carbohydrates for more than 48 hours prior to the exam; h) vital medicines like: steroids, sympathetic blockers, vasodilatation drugs, morphine and analogous, transdermics medications must be used and informed, but if it is possible it can be discontinued for 8-16 hours; i) avoid intensive physical exercises for 24 hours; j) in case of fever or infection in the last two days or significant emotional stress in the day before the exam or hypoglycemia during fast period or if the patient could not follow all the instructions, the exam will be cancelled; k) not be submitted to any kind of muscle and bone manipulations as acupuncture, physiotherapy or electrical diagnoses exams in the last 12 hours; l) at the end of the exam fill the form with the patient data: weight, size (to calculate body mass index and body surface), circumferences of arm, abdomen, waist, wrist and hip and measure of biceps, triceps, subscapular and supra-iliac skin folds.

It is painless, quick (no more than 15 minutes), made in an acclimatized room at 23oC, without any ultraviolet exposure, wearing a comfortable gown covering all the body parts that are not relevant, standing, in front and back positions, without any physical contact to objects or persons, in a resting position for at least 20 minutes inclusive for acclimatization, using an appropriate thermographic camera.

CONCLUSION: The average temperature of the patient and his emitted radiation may be evaluated. Using adequate formula the value of the radiated energy in Watts is converted in Kilo-ca lories/hour and finally Kilocalories/day.

EXPERIENCES WITH THERMOGRAPHY IN A CLINICAL SETTING

J.B.Mercer, [a,b], L. de Weerd.[c].

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b Department of Radiology and c Department of Plastic and Hand Surgery, University Hospital North Norway

At the University Hospital of North Norway we have the only specialised laboratory for clinical and experimental medical thermography in Norway. The laboratory is run in collaboration with the Faculty of Health Sciences, University of Tromsø. We have experience in thermographic imaging for over 10 years and have collaborated with many different Departments within the Hospital. One of our main interest areas is related to the use of this technology in plastic and reconstructive surgery. Our imaging software has been adapted to the hospitals picture archive and communication system (PACS). Our experimental studies have been extensively published (ca 20 publications, including 3 book chapters, during the last 5 years). Examples of our publications include the general understanding of thermal signals1, as well as the use of DIRT in orthopaedics (tendenitis)2, in plastic surgery3,4, and in isolated perfused human abdominal skin flaps5. Our research has also resulted in the production of 2

PHD's and several MSc's with medical thermography as their main theme. In this talk examples of the use of thermography in a wide range of clinical settings will be presented, ranging from plastic surgery, orthopaedics, heart surgery, anaesthesiology to breast cancer.

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2. Meknas K., Miland Å.O., Mercer JB., Castillejo M, Johansen O. The American Journal of Sports Medicine, 2008, 36:1960-1965.

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PAIN AND REHABILITATION

CORRELATIONS BETWEEN QUANTITATIVE SENSORY TEST AND INFRARED THERMOGRAPHY IN LOW BACK PAIN PATIENTS - A PILOT STUDY.

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BACKGROUNd: Infrared Thermography (IT) has been proposed as a potential tool to assess musculoskeletal pain. However, there is a paucity of studies evaluating the correlations between low back pain, trigger points (TrP) and thermogram data.

METHODS: Thirty patients with primary low back pain (average pain VAS> 30mm) and active TrP were included. They filled out the first part of the Brief Pain Inventory and underwent low back IT and mechanical quantitative sensory testing (mechanical detection, pain and supra-threshold-MDT, MPT, MSupra) of four points marked on the skin: the most intense pain location (MIPL) as pointed by the patient, its mirror area in the contralateral side (MIPL-mirr); the skin area over the main active trigger point (MATP) and its mirror area (MAPT-mirr). MIPL was central (MIPLA-C) when located + / - 1 cm from the midline and lateralized (MIPL-L) when > 1 cm. IT: Patients were evaluated unclothed, two meters away from the camera in a 22° C room (A320, FLIR, USA)

RESULTS: Twenty-eight patients were included (47 years, 22 female; VAS = 51 mm). MIPL-L was lower than the MIPL-C [40.0 (12-93) vs. 69.2 (34-90); p = 0.009). MSupra in MIPL-C was more intense than in MIPL-L (81.6 ±15 vs. 66.0 ± 20.1; p = 0.049). The difference between MIPL and MIPL-mirr MSupra scores correlated to the IwVAS score (rho=0.51). MIPL and MATP X and Y coordinates showed high correlation (rho=0.76 and 0.50). Temperature on MIPL and MTPL correlated (rho=0.83).

CONCLUSIONS: Centrally located pain was more intense and presented higher mechanical hyperalgesia than lateralized pain. The area of maximal pain was spatially close and presented similar temperature as the area over the MATP.

SAO PAULO UNIVERSITY HOSPITAL PROTOCOL FOR PUBALGIA.

Mônica Lourdes de Andrade Lima, Marcos Brioschi, Manoel Jacobsen Teixeira.

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The mechanical pain in the groin area represents an important and often confusing clinical dilemma. This is especially true in the osteitis pubis, an inflammatory condition affecting the pubic symphysis.

The osteitis pubis (pubalgia) is a syndrome characterized by inflammation of the pubic symphysis and pain at tendons of the adductor muscles of the thigh.

The first citation in the literature was made by Beer (1924) as a result of a complication of urologic surgery. Currently, although relatively benign, has been recognized as a potential source of pain in athletes and have high morbidity, razing careers at the peak of their performance or on the rise.

The infrared image has been used more since 1990 in a range of diseases. It is a non-invasive diagnostic method, non-ionizing radiative, easy to perform. It gives rapid response, able to quantify objectively by image, the inflammatory reactions of the musculoskeletal system. It plays an important role in monitoring the inflammatory activity and therapeutic assessment.

Thermographic examinations can be performed in patients with symptoms of pubalgia, which were properly acclimated in accordance with standard protocols.

Patients with pubalgia complain of dull pain, nonspecific bilateral pelvic throughout the region of the symphysis pubis, lower abdomen, groin and buttocks and thighs at the root of the musculo-tendinous insertions and occasionally concomitant stiffness. This pain is aggravated with the same efforts and relief with rest.

The causes of pubalgia may be of infectious origin or may not, for example:

- Enthesopathy of the proximal attachment of the middle adductor;
- Loss of strength of the abdominal wall or inguinal channel;
- Changes in the morphology of the hip joint;
- Fatigue fracture of ischiopubic ramus and femoral groin;
- Groin tumour
- Inguinal or crural herniations
- Endometriosis

The clinical diagnosis can be evaluated with Records maneuver (2000). This maneuver studies the instability of the pubic symphysis through the imbalance of the adductor muscles and rectus abdominis. The test is done with the patient in supine position, with an extension of the limbs, and the other extremity in abduction and external rotation of the hip and knee flexion of about 70o. The examiner with one hand abduction strength by asking the patient repeated bending of the abdomen. The maneuver is considered positive when the patient is unable to complete the movement because of pain in both groin and pubic area.

For imaging diagnostic, it can be utilized abdominal X-ray, CT and MRI of the pubic symphysis. Plain radiographs are routinely requested for evaluation of bone degeneration, bone cysts and bone tearing. The CT scan evaluates the location of degenera-

tion, loose bodies, and the MRI identifies osteonecrosis of the pubic symphysis in sedentary or in the case of an inguinal hernia suspicion.

The IR thermography will be held without prior 12 hours of manipulation of the patient (physical therapy, acupuncture, massage etc). In the case of female patients it is better to avoid the menstrual period for not to interfere with the thermovascular pattern. It is necessary to communicate the patient about the procedure and provide informed consent that should be signed by him. It must also get a brief history of the disease and record tests performed before as well as examination of the skin (varicose veins, skin folds, wounds, bruises, tumors etc).

The examination must be conducted in 23°C room temperature and the patient should be acclimatized naked for 15 minutes without touching, rubbing or pressure the skin.

For positioning, it is necessary the patient stay standing up and record whole-body imaging (front and back), anterior, posterior and lateral pelvic region and after in the gynecological decubitus for pelvic region images (anteroposterior, posteroanterior, right and left anterior oblique, lateral internal and external sites).

The thermal images are saved in separate folders named for each patient. The thermograms should be carefully examined objectively in a few specific colour palettes. It should be measured maximum, minimum and the median temperature in the region of interest (ROI), mean temperature distribution (thermographic index - TI) and average density of the temperature distribution in the ROI (histogram).

The achievement of qualitative and quantitative analysis depends also on image quality and resolution of the device.

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A CONTROLLED, DOUBLE BLIND AND RANDOMIZED STUDY FOR EVALUATION OF THE EFFICACY AND SAFETY OF INVEL® ACTIIVE SHIRT WITH INVEL® TECHNOLOGY.

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Lumbar pain (or low back pain), especially, reach epidemic levels in world population. It is estimated that 70 - 85% of the people will have low back pain in some time in life. Since low back pain is chronic and often debilitating, search for new procedures which present low risk of use and promote increase of the patients' quality of life is necessary. Long?wave infrared phototherapy has been evaluated in some clinical studies that showed decrease and disappearance of pain in patients with column pains (1,2). And the Invel® Actiive Shirt can be used as a non?invasive and practical coadjuvant therapeutic tool that could be incorporated in orientations for those who suffer from pain along the vertebral column.

OBJECTIVE (1) To evaluate the efficacy of the shirt, Invel® Actiive Shirt, in low back pain, especially muscular pain.
(2) To evaluate safety in the use of the product.

METHODOLOGY: A national single. center randomized, double blind, placebo controlled study including a sample of 70 subjects with history of chronic low back pain with at least 3 months of progress on the date of inclusion. The subjects were randomized into two groups. One of the groups used the shirt Invel® Actiive Shirt (group A) and the other used shirt with no Invel® technology (group B). The subjects were treated for 14 days and evaluated at times 0, 7 and 14 days.

(a) GI1: Global impression of improvement of pain is evaluated;
(b) Product safety was measured by the proportion of patients that did not present serious or non?serious adverse events, related to the use of the product;
(c) Thermography: To assess superficial blood perfusion.

RESULTS: Seventy (70) subjects from both genders (77.75% women), average age 48.38 years old were included. The subjects were assigned at random, but the study was concluded with 29 subjects that used the shirt Invel® Actiive Shirt and 25 the shirt with no Invel® technology.

IMPROVEMENT OF PAIN: With respect to the global impression of improvement, in visit 3, there was statistically significant difference between the two (A and B) groups (p=0.0362). The obtained results were "improved a lot" (A: 24.14% vs. B: 4%) and "moderately improved" (A: 44.83% vs. B: 28%).

THERMOGRAPHY: The white area in the image represented the stricken low back region and the red area represented the area of increased blood perfusion. The decrease in size of the white area was compared between visits V1 and V3 in the two treatment groups A and B. We observed that improvement of the thermo graphic pattern of group A was 24% vs. 11% of the control group, group B.

SAFETY: No clinically significant event was verified in the studied population.

CONCLUSION: The increased blood perfusion by surface heat promoted by the fabric of Invel® Actiive Shirt is resulted of a photochemical effect. It occurs due to increase of tissue perfusion promoted by heat, aid in the removal of substances that cause pain and increase of oxygen supply to the site and local nitric oxide release. The use of the product does not lead to cure of the disease, but it is an auxiliary resource in the treatment of low back pain. The heat promoted by long?wave infrared radiation attenuates painful symptoms by preparing the stricken region for the application of other traditional therapies.

ANVISA, National Health Surveillance Agency, recognized the efficacy and safety of this product and granted the registration ANVISA MS No. 80104760005 on 01/18/2011.

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A SINGLE?CENTER, PROSPECTIVE, CONTROLLED, DOUBLE BLIND AND RANDOMIZEDSTUDY FOR EVALUATION OF THE EFFICACY AND SAFETY OF INVEL®
ACTIIVE GLOVEWITH INVEL® TECHNOLOGY.

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Repetitive movement related disorder (RSI: repetitive strain injury / WRMD: work related musculoskeletal disorder) of the hand and the wrist is associated with extended absenteeism from work, therefore, associated with the greater productivity loss (1). More than 90% of patients with RSI/WRMD prevented musculoskeletal pain and strong association with Myofascial Pain Syndrome (MPS) (2) was observed. MPS is one of the most common causes of musculoskeletal pain and functional incapacity. It is little recognized by health professionals, since the diagnosis depends exclusively on clinical history and physical examination findings. MPS is a regional neuromuscular dysfunction, with trigger points in the tense bands of muscle fibers and when stimulated mechanically it presents local or referred pain in distant areas. MPS can be silent, in intense heat and stabbing sensation. It can become extremely strong that it can be confounded with bone pain, which hampers diagnosis (3). Myofascial trigger point (TP) can cause a tingling sensation and numbness. In tis situation, the electroneuromyographic examination and the neurological examination are normal. Many of the myofascial TPs are referred pain, that is, they are far from the stricken site (4). Treatment is clinical and consists in medication, physical means, kinesiotherapy, ergonomic orientations, use of orthosis, and postural hygiene for improvement of pain and functional incapacity. The use of long?wave infrared radiation emitted by Biocerâmica® incorporated in Invel® Actiive Glove can be another coadjuvant treatment option for alleviating pain and aiding in rehabilitation (3).

OBJECTIVE: To verify the efficacy of Invel® Actiive Glove in muscular pain in patients with MPS in the wrists. To evaluate functional capacity of upper limbs of patients with MPS. To evaluate safety in the use of the product.

METHODOLOGY: A single-centre, prospective, controlled, double blind and randomized study was performed, approved by the independent ethics committee on research, including a sample of 60 subjects suffering from MPS caused by RSI on the upper limbs. Sixty (60) subjects from both genders were selected and, after signing the informed consent form, randomized into two groups: Group A (group that used Invel® Actiive Glove) and Group B (placebo, which used the glove of the same fabric, however with the incorporation of Biocerâmica® MIG3®). The subjects used for 6 hours daily for 28 days. For the two groups, A and B, 4 visits were planned in the course of 2 months.
Means of evaluation: (a) Pain by the Visual Analog Scale - VAS;
(b) DASH (Disabilities of the arm, shoulder and hand) Functional Assessment;
(c) Assessment of the TPs (by the Fischer algometer);
(d) JAMAR (grip dynamometer);
(e) Clinical assessment.

RESULTS: Intensity of Pain: A drop of VAS was confirmed in the right arm by 12% in V2, 28% in V3, in Group A (group that used Invel® Actiive Glove) and variation of 11% in V2, 14% in V3 in Group B (placebo). Clinical Assessment of the Pain: The location and reduction of pain were assessed and it was observed significant differences in their absence at times of 14, 28 and 56 days compared to the baseline time, at the elbow and wrist, with 5% significance level. Functionality: There was decrease of DASH scores, suggesting improvement of functionality in the two groups ($p<0.0001$). Safety: No clinically significant adverse event was verified in the studied population.

CONCLUSION: This study showed clearly that Invel® Actiive Glove leveraged the analgesic effect. Mild compression exercised by the gloves aids in muscular stabilization and reduces vibration resulting from impact with movements. This product can be used as coadjuvant treatment in pain of the forearms and wrists.

ANVISA, National Health Surveillance Agency, recognized the efficacy and safety of this product and granted the registration ANVISAMS Nº 80104760006 on April 25, 2011.

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KINESIOLOGIC THERMOGUIDED EVALUATION BY ANALYTICAL MYOMODULATION

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It is recognized that chronic pain involves a complex network neurological, musculoskeletal, metabolic, psychological and behavioral phenomena. These feeds back neuro-musculoskeletal changes creating a vicious circle that worsens the pain in intensity and extent. According to this aphorism, the theory of the Analytical Myomodulation (AMM), seeks to justify the complex painful process and its chronic evolution, looking for interrelation between the present biomechanic changes and these phenomena. The Analytical Miomodulation (AMM) is a new neurological therapeutic model, whose theory presents the mapping of 25 muscle groups by its patterns of change related to the presence of strained bands (BT), tension points (TP) and increased muscle tone (MT). The purpose of AMM is not only diagnosis but to guide and monitor the treatment based on these characteristics changes. The aim of this study was to map the patterns by infrared thermography. For images analysis was utilized Regressive Temperature (RT) method. The RT analysis consists in the study of the involved muscular groups. It is based from the increase of infrared radiation associated with metabolic phenomena in neuromusculoskeletal disorders. It was realized kinesiologic thermoguided evaluations by AMM method in 30 patients with chronic pain. First was clinically mapped the groups (patterns) muscles altered followed by thermography exam. It was captured 420 images. By means of thermographic analysis using RT method the authors concluded that was possible to map the patterns of AMM theory. Once identified it was possible correlate them with the site of neuro-musculoeskeletal pain and its cause.

USE OF THERMAL IMAGING IN THE DIAGNOSIS OF REPETITIVE STRAIN INJURY

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SITE: This study was developed in the Master Degree Program in Health Technology at Pontifícia Universidade Católica do Paraná..

OBJECTIVE: To discuss the effectiveness of the technique of thermography in the diagnosis of repetitive strain injuries /work related musculoskeletal disorders (RSI/WRULD).

METHODS: we performed the bibliographicsearch in database MEDLINE on the use of infrared images in repetitive strain injuries. We selected articles that used individuals with a diagnosis of RSI/WRULD, proven by clinical tests and medical imaging (MRI and ultrasound) and compared with the thermographic images.

RESULTS: In all the articles reviewed, there was change in temperature in relation to pathology in the study area. Studies using thermography in patients with fibromyalgia had occupational changes as a result of temperatures from 0.5 ° to 1 ° C over the trigger points. The diagnosis of fibromyalgia is complex and people with fibromyalgia have pain in 18 bilateral points on the body. Comparative studies of the clinical examination and thermography showed at every point triggers changes in temperature. The carpal tunnel syndrome is diagnosed by examining pre-clinical symptoms of damping in the region innervated by the median nerve and the disease is evidenced by magnetic resonance imaging of the wrist and fingers. Thermal imaging exams showed a decrease in the issuance of the vascular pattern of heat on the median nerve distribution. Thermography detected pathologies such as vascular and mononeuropathies vasoespamos both very common in industrial titled regional pain syndrome reflex. Compared to ultrasound, thermographic images have shown a reduced temperature of 0.8 ° C in the affected regions. With regard to inflammatory processes, few articles have reported that inflammatory pain in upper limbs, more specifically in shoulder and elbow were diagnosed by clinical examination but not confirmed by ultrasound. However, in examining areas of thermography were presented with changes in temperature between 0.9 ° to 1.8 ° C. In addition, specific literature emphasizes that the inflammatory process increases blood flow and, consequently, increases the local temperature.

CONCLUSION: Thermography was effective detecting slight changes in temperature, proving to be a complementary method for quantitative, objective and useful in supporting the diagnosis of RSI/WRULD.

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THERMOGUIDED MESOTHERAPY

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OBJECTIVES: Author's intention is to demonstrate importance of thermography application allied to musculoskeletal pain treatment technique so called Mesotherapy, either before the application, as an auxiliary diagnosis method, or in post-treatment evaluation (evolutionary results follow-up). Mesotherapy is a medical treatment technique, composed by the application of small doses of mixed remedies, through intradermic injections, after defined clinic-laboratorial diagnosis and following anatomic references specific to the diagnosis. It was mentioned first time in 1952 by Michel Pistor in France for presenting positive therapeutics results in the treatment for many different pathologies, especially in the treatment of inflammatory arthropathies, traumatic injuries related to sports practice and muscle contraction, besides neck and back pain and peripheral neuropathies such as carpal tunnel syndrome. The medication application following this technique is done in the reticular skin (depth between 4 to 6 mm). Depending on the diagnosis and inflammatory process phase (acute, sub-acute or chronic), a different set of remedies is chosen.

METHOD: Patients having pain and diagnosed with following listed diseases were evaluated with thermography pre and post mesotherapy: tennis elbow, neck and back pain, carpal tunnel syndrome, plantar fasciitis, myofascial trigger points in trapezius and extensor forearm muscles. Images were collected immediately before application, 20 minutes after treatment and later (period between 24 hours and 7 days, when patient returned for medical review). A temperature difference of 0.5 degrees Celsius or higher against same contralateral point or surrounding area was used as thermographic criteria, confirmed later by pressure algometry (reference standard).

RESULTS:The image taken before procedure was considered highly important to the applicant physician due to diagnosis precision and pain point location, thanks to the thermography, especially when myofascial trigger points concurring to articular inflammatory process exist. Thermography evaluation immediately after procedure does not seem to have clinical value and was discarded during study continuation. In the other hand, images taken during evolutionary follow-up are of high importance, serving also as an objective criterion of treatment discharge.

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APPLICATION OF INFRARED THERMOGRAPHY IN STUDIES OF ACUPUNCTURE-MOXIBUSTION AND MERIDIAN

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To introduce application of infrared thermography in studies of acupuncture-moxibustion mechanisms and meridians in this paper. The results of the author's researches on acupuncture and moxibustion with infrared thermography are reviewed comprehensively, including:

1. the results of acupuncture and mox bustion for treatment of diseases;
2. the temperature-increasing action of acupuncture and moxibustion;
3. relative specificity phenomena of acupoints;
4. temperature characteristics of meridians;
5. meridian and acupoints-viscera correlation.

Thus, the feasibility of application of infrared thermography to studies of acupuncture and meridian is confirmed and a lot of significant research results are achieved, developing the application fields of thermography.

FIBROMYALGIA SYNDROME: THERMOGRAPHIC SCORE

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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 absence 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.

FIBROMYALGIA: EVALUATION BY THERMOLOGY

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INTRODUCTION: The fibromyalgia diagnosis is often given to the individuals with diffuse chronic pain which intensity range over the time. The morning stiffness and limb or articulation edema are often associated to abnormality cognitive and the humor, persistent fatigue and besides them the sleep disorder. It is also reported the gastrointestinal symptom and bladder disorder. There is an agreement of its heterogeneous fisiopathology with characteristic and variable therapeutic response.Evidences show the main component of the pain in the fibromyalgia is related to the central sensitization with symptom amplification. The prevalence in the adult population is 2 to 5% and it predominates in women on the proportion of 8 to 9 women/ 1 man, age range : 35 to 60 years. There are no laboratorial abnormalities evidences or exams such as radiography, ultrasonography, computerized tomography or even nuclear magnetic resonance. The infrared imaging exam fulfill this large diagnostic opening that can detect physiological changings and the metabolic processes at the same time, and helping in the diagnostic confirmation and the fibromyalgic patients follow up.

PROCEDURE: The patient must be 15 minutes undressed to equalize its temperature with the climatized environment at the 23°C degree, air humidity in 60%, air conditioning with air current <0,2m/s, thermic isolation environment and the distance between the camera and the patient must be 4m with the whole body filming. The fibromyalgic patient presents a heated image on the trunk region of a mantle shape caused by thermo-regulation disorder associated to the cold extremes by the periferic vasoconstriction and the eyelid heating, known as owl eye due to the sleep disorder.

CONCLUSIONS: The infrared imaging is a non ionizing diagnostic method, painless without radiological contrast and it can be applied at all ages, also pregnant. It can be applied for the chronic pain understanding such as fibromyalgia.

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THE INFRARED (IR) IN TISSUE REPAIR PROCESS AND ITS RADIATOR BIOMATERIALS APPLIED IN DENTISTRY

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STUDY: Project - Consulmat; Production - Vedovato; Analysis - IPEN

OBJECTIVE: A series of ceramic and polymer compounds shows own characteristics of its physical-chemistry conditions in the transmission of waves in the far infrared range when thermally stimulated. Infrared spectra are shown for some compounds used in dentistry. The evaluation on tissue temperature adjacent to some compounds, due to the infrared radiation, is correlated to the reflectance spectrum characteristic of each material.

METHOD: The study was conducted in three environments:
(a) prosthetic laboratory for the production of the specimens,
(b) analytical laboratory for achievement the IR spectrum of the specimens, and
(c) dental office for the thermal measurements performed on patient. The equipments used in the production of the specimens were those of the usual prosthetic manipulation.

The analytical equipment to survey the thermal measures were:
(a) infrared spectrum - infrared spectrophotometer Thermo-Nicolet Nexus 400;
(b) tissue thermal profile - Thermovision Camera Flir E60.
The interpretation of infrared spectra were used the tabular data to identify the absorbance peaks. For tissue thermal analysis, records were taken into a room with controlled temperature 21 ± 1 degrees Celsius after 15 minutes of acclimatization. The projections were taken ahead on the specimen and surrounding tissue. Data evaluation was based on images taken in different colors, corresponding to different temperature levels according to the scale of the equipment.

RESULTS: A typical distribution, with gradual changes in temperature between the warmer areas (adjacent to the specimens) and cooler (distant from the specimens) was observed in the evaluated soft tissue (gingival mucosa).

CONCLUSIONS: The use of thermographic camera (thermo-vision), by the investigations carried out, offers efficiently diagnostics on the thermal effects of the studied dental materials. The correlation between the IR spectral profile of each material and the thermal change in the adjacent tissue region suggests that it is feasible.

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SAO PAULO UNIVERSITY HOSPITAL THERMOGRAPHY PROTOCOL FOR COMPLEX REGIONAL PAIN SYNDROME (CRPS)

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The diagnosis of CRPS continues to be subjective, rather than by the application of consistent criteria that can be quantified (Wilson & Bogduk, 2005).

For the diagnosis of infrared CRPS consider the record of three distinct signals: 1 Index: Asymmetry infrared region of interest greater than 0.5oC (Delta T, Nl<0.5oC) Index 2: discontinuity of the distal infrared thermal gradient; Index 3: the paradoxical response functional testing of the cold water autonomic stress ("Cold stress test").

Sensitivity and specificity of 93% to 89% positive predictive value (PPV) 90% and negative predictive value (NPV) 94% in a group N =205 were observed by Gulevich, Conwell, Lane et al. (1997).

Sensitivity, specificity and predictive value of infrared cold water autonomic functional stress testing was compared with modified IASP criteria for CRPS. (Conwell, Hobbins, Giordano, 2010).

This paper aims to standardize and develop a protocol to evaluate the function of the reflex cutaneous vasoconstrictor sympathetic vasomotor response by quantifying the end of the stimulus symptomatic cold water from one end of a symptomatic we call "Cold Stress Test" from the required specifications for setting up a laboratory for the examination of infrared, and prepare recommendations to the patient, setting, forms and explanations.

IS IT POSSIBLE TO DISTINGUISH THE REFERRED PAIN TO LOCAL PAIN IN MYOFASCIAL TRIGGER POINTS BY INFRARED THERMOGRAPHY?

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Infrared imaging instruments, applicable to routine clinical examination, need to be evaluated for their potencial as a diagnostic aids in dentistry. The aim of the study was to identify, quantify and correlate myofascial trigger points in the masticatory muscles, using thermography and clinical examination. Twenty six women volunteers were recruited. The surface facial area over the masseter and anterior temporalis muscles was divided into 15 sub-areas on each side (n=780). This investigation consisted of 3 steps. The first step involved thermographic facial exam, using lateral views; all subjects complied with the preexamination recommended by the Academy of Neuro-Muscular Thermography. The second step involved the pressure pain threshold, marking the myofascial trigger points pattern areas for referred pain (n=131) and local pain (n=282) with a colored pencil; also, a photograph of the lateral face, with the head in the same position as the infrared imaging. The last step was the fusion of these two images, using specific software; also, the calculation of the temperature of each point. Results showed that pressure pain threshold levels measured at the points of referred pain (1.28±0.45 kgf) were significantly lower than the local pain (1.73±0,59 kgf; $p<0.001$). Infrared imaging indicated differences between referred and local pain of 0.5ºC ($p<0.001$). Analysis of the correlation between the pressure pain threshold and infrared imaging was done using the Spearman non-parametric method, in which the correlations were positive and moderate (0.4?r<0.7). The sensitivity and specificity for referred and local pain were 62.5% and 71.3%, and 43.6% and 60.6%, respectively. In conclusion, infrared imaging measurements can provide a useful, noninvasive and nonionizing exam for diagnosis of myofascial trigger points in masticatory muscles.

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SAO PAULO UNIVERSITY HOSPITAL THERMOGRAPHY PROTOCOL FOR SACROILIITIS

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The objective is to create a protocol to estimate the temperature of the sacroiliac region and use thermography for the diagnosis of sacroiliitis.

Thermography is an extremely sensitive method able to identify the beginning of the inflammatory process, even before its clinical manifestation. It is a non invasive and without ionizing radiation exam.

Patients should be kept full-body uncovered in a programmed position in a room with an ambient temperature of 23°C for 15 minutes before and during the examination.

It should be take thermograms near the sacroiliac region in five regions, 1) the lumbar spine, 2) iliac crest, 3) sacrum, 4) sacroiliac joint top and 5) bottom using isotherm system to analyze it. The shape of the temperature curve in the lumbosacral region is characteristic symmetrical in healthy people.

The temperature is highest in the lumbar spine, followed by the top of the sacroiliac joint sand the base of the tail bone. This is attributed due to the upright formed by the erector spinae and gluteal muscles. n the lumbosacral region of women is observed a hyporadiant image than in men due to greater thickness of the panniculus in this region. It has been observed that there is a thermal profile characteristic of the sacroiliac region, although there may be large temperature differences in individual cases. But ankylosing spondylitis patients with sacroiliitis there is a asymmetrical distribution with local hyper-radiation. These findings must be correlated with clinical evaluation because there are some differential diagnoses: herniated discs, bone metastases, musculo-ligamentous injuries, scoliosis and skin conditions.

CONCLUSION: he thermographic examination protocol of the sacroiliac region may contribute with additional information in conjunction with clinical evaluation and laboratory tests, diagnosis, evaluation and follow-up therapy.

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BREAST CANCER / ONCOLOGY

DIGITAL INFRARED THERMAL IMAGING (DITI) FOR BREAST SCREENING

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The first thermal image of a person was taken in 1948 and took 40 minutes. Since then our understanding of thermal physiology has advanced significantly and with the additional advances in infrared imaging technology providing high levels of sensitivity, specificity and accuracy with stable and repeatable temperature measurement to 0.01C. Today, over 2,000 patients per day are being breast screened with thermography in the US and this is building a very substantial central database with millions of patients available for ongoing research and studies. Standardized interpretation and reporting by board certified physicians, aided by innovative interpretation software (artificial intelligence) has also advanced the acceptance of thermography as a mainstream medical test.

One of the most exciting applications of DITI now gaining more practical use is breast screening, even though it had been approved by the US Council of Diagnostic Imaging since 1988, it continued to be controversial for many years. The role of DITI in beast screening is now widely accepted and is no longer considered competitive with structural tests like mammography. It is especially useful in younger women (30 to 50 years old), who have denser breast tissue which decreases the effectiveness of other studies.

It takes years for most cancers to develop to the stage that they can be detected with mammogram or ultrasound (dense enough for location and biopsy) so DITI is ideally placed as a screening tool to identify changes over time in the 'early' development stages, before there is more advanced pathology that can be detected with other tests. The major benefit in this group is in detecting early changes that precede malignant pathology that will become diagnosable at some later stage.

Early detection is aimed at prevention and if early changes are detected then we have an opportunity to intervene and change the outcome. Prevention may include treatment of inflammation or vascular activity, fibrocystic disease, lymph congestion, estrogen dominance, more specific conditions like angiogenesis, and other 'functional' abnormalities. There are no contraindications for DITI as it is totally non-invasive, no radiation of any type, no contact with the body so it can 'do no harm'.

In patients of mammographic age (generally over 50), DITI not only provides the benefit of early detection of functional change but can also increase the detection rates of other tests by contributing additional information about functional (physiological) abnormality and also the location of suspicious (positive) thermal findings that may be outside the range of other tests due to location, size of breast, implant, or other limiting factors.

DITI as a screening test in all age groups is designed to establish a baseline (the patient's normal thermal fingerprint) for ongoing comparative analysis (normally annual) to detect any physiological change that justifies additional testing.

The changes that DITI can detect include, inflammatory pathology (inflammatory carcinoma/inflammatory breast disease), infection, lymph dysfunction, vascular changes and also any suspicious activity outside the range or scope of other tests (outside the boarder of the breast, in the sternum or axilla).

SAO PAULO UNIVERSITY HOSPITAL THERMOGRAPHY PROTOCOL FOR BREAST CANCER.

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Breast cancer is a public health problem worldwide. Although major technological advances have increased patient survival, early detection and reduced mortality are still the subject of many studies. Currently, mammography has been considered the gold standard test for detecting breast cancer, however, this method is limited to the study of dense breasts of younger women, and is radiation emitting. Studies with infrared thermography of the breast have shown this to be a promising method for population screening and risk assessment. The objective of this study is to establish an examination protocol using infrared thermography.

LEVEL OF BREAST CANCER RISK ASSESSMENT USING A STANDARDIZATION METHODOLOGY OF CUTANEOUS THERMAL IMAGES

Ionildo José Sanches, Marcos Leal Brioschi, Daniel Colman, Eduardo Adrat, Vanessa Andreoli, Jose Vargas.

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OBJECTIVES: This paper aims at the development a non-contact system for assessing the degree of risk of breast cancer using normalized values of adimensional temperature.

METHOD: To develop the computer system, we used a standardization methodology of cutaneous thermal readings (Brioschi, 2011). In this methodology, we are considering the environmental temperatures and patient's central body temperature for medical infrared thermography studies. The non dimensional normalized temperature values are between 0 and 1, with the 0 value being when the temperature is equal to environment temperature and 1 when the temperature is equal to central body temperature. The infrared images acquisitions are made by using a FLIR ThermoVision® A320 infrared camera, with 320 x 240 pixels resolution. To assess the level of breast cancer risk are acquired six images of the patient's breast, wherever: front breast image, skewed image, left oblique, oblique right oblique, left profile and right profile. In addition to these six images it is also used two images to provide environmental temperatures and patient's central body temperature.

RESULTS: We developed a computational system to acquire the infrared images, display grayscale and pseudo-color images, selection of regions of interest (ROI), imaging processing and imaging analysis using the adimensional temperature. Through the temperature conjugated gradients method is considered the normalized temperature difference (?T or asymmetry parameter) compared to the contralateral side (?). This value is then displayed on a risk scale ranging from 1 to 5. Display images are used a palette of gray levels in regions that have no risk and pseudo-color corresponding to the levels of breast cancer risk.

CONCLUSION: he infrared imaging is a safe and valuable setting to identify benign and malignant disorders. Using the adimensional variable ? method, considering the environmental temperatures and central human body temperature (metabolism of the individual), is used to identify cut-off values of normality and thus determine the patient level risk.

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AUTOMATED COMPUTER MEDICAL THERMOGRAPHIC DIAGNOSIS. BRIOSCHI ML, YENG LT, MATIAS EF, SILVA FMRM, TEIXEIRA MJ.

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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, 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.

VASCULAR

SAO PAULO UNIVERSITY HOSPITAL THERMOGRAPHY PROTOCOL FOR ENDOTHELIAL DYSFUNCTION.

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INTRODUCTION Endothelial dysfunction has been investigated in recent decades and accumulated evidence suggests that this phenomenon occurs since the beginning of atherosclerotic disease (1). More than that, revealing a number of articles and publications in cardiology has shown that endothelial damage appears to be closely linked to significant cardiovascular outcomes such as myocardial infarction and stroke (2).

Some methods have been used to measure endothelial function for 50 years. Veno-occlusive pletysmography is the oldest and others have arisen in this field in particular the use of flow-mediated dilation (FMD). The first description was made to Celermajer (3,4) with ultrasound in 1992 and later other publications have confirmed that there is strong evidence that the ultrasound probe with high frequency in the brachial artery can provide reliable data on the vasodilatation endothelium-dependent and, indirectly, the integrity of endothelial cells (5). Added to this, since there is a guideline created with support from the American Heart Association since 2002 to evaluate the flow mediated dilation with ultrasound (6).

However limitations occurred since the beginning, because this guideline did not conclude on the cutoff point of brachial arte-

rial dilation that can be considered as an abnormal test. Another problem, perhaps the worst to solve is related to the inter-observer variability considered high by current concepts from the evidence-based medicine to test for accuracy (7,8). Of course these limitations this method to bring questions about their potential use in medical practice.

Recently some authors have studied alternatives using the same physiological response (FMD) in their publications and contact thermography using the results were very encouraging. At least three results of scientific papers written by et Ahmadi at al showed a strong correlation between the temperature at the ends of rebound of fingers after the compression arm and the other methods often used to diagnose coronary artery disease such as coronary angiotomography (9), calcium scoring (10) and myocardial scintigraphy (11).

In this new scenario thermography can occupy a prominent position in the arsenal of diagnostic methods in cardiology. But despite promising thermography will have to present relevant results, and the methods available today for already established that the method can be incorporated into routine care.

According to this perspective, our group at the University of São Paulo developed a protocol to assess the thermographic endothelial function. Our main goal is to study the test thermographic (Brachial test) in various clinical situations.

PREPARATION OF PATIENT (12).Patients should be instructed to suspend for 24 hours vasoactive medications, opioids, transdermal patches as well as vitamin C, soft drinks, tea, coffee, alcohol and tobacco. The last meal should be made 10 hours before being released to the examination of water intake.

The recognition phase of the menstrual cycle on the part of patients and relevant since this factor can affect the flow-mediated dilation. In this case the patients were rescheduled and preferably out of the scheduled period.

The use of hormones does not contraindicate the examination but this should be an award described in the chart. Since estrogen can increase the hyperemic response.

Exercise, acupuncture, physiotherapy and physical manipulation, TENS applications as well as other electro diagnostic methods should be avoided 12 hours before the test drugs as beta-blockers should be discontinued 48 hours before the test.

Local treatments with oils or cosmetics should be avoided on the day of the exam and a bath with warm water two hours before the method can help keep your skin clean and free of cosmetics.

Avoid using tight clothes, compression, as well as chains, rings and other trinkets during the examination.

It is suggested that thermography is preferably the first test of the day, since other tests can provide thermal artifacts.

PROTOCOL: The protocol provides thermographic examinations there is a period of acclimatization of the patient for 15 minutes to the release of heat retained by the clothes.

For the examination of thermography in order to evaluate endothelial function and necessary for the upper body is exposed, and there the same need for the bottom that may be covered with fabric since it is light cotton or similar, as well as the breast region preferably provided by the laboratory.

The patient should be instructed not to cross your arms or keep them flat on the lateral side of the body to a more effective thermal equilibrium. At this stage the patient can lie.

EXAMINATION The patient will have after the period of thermal equilibrium sit comfortably on a stretcher with his legs flexed out of the litter. The patient's arms should rest lightly on the legs so that the front edge of the hands are on their knees touching only slightly, without compression.

The medical investigator must be a minimum distance of 1 meter and a maximum of 2 meters of the patient with the infrared camera mounted on a vertical support, focused directly on the exposed surface of the front of the patient's hands checking the temperature of an area made up by least two fingers (distal ends) of each hand in order to arrive at a baseline temperature measurement in both right hand and left.

The camera should be set to measure emissivity of 0.98 and infrared images measured their temperatures should be archived.

The following should do the compression of the left forearm of the patient with the sphygmomanometer cuff to achieve the stated value of 240 mmHg at 5-minute break in order to promote distal limb ischemia.

Throughout the compression step of the arm the patient should be standing with the limb at rest while the operator will keep reaping so images of the previously selected edges (similar to local baseline measurement) in both hands. So far as these thermal baseline data during the compression of the arm must be recorded and archived in accordance with the values expressed in color temperature for later analysis with the help of specific software.

After a period of 5 minutes of upper limb ischemia should be done decompression arm allowing the restoration of blood flow. It is important that the patient does not move your arms right now. This period following the 0 to 5 minutes after decompression of the arm and called step flow mediated dilation characterized by reactive hyperemia and of singular importance in this provocative examination. During this step the operator must perform thermal records in the same way with the period of compression.

CAPTURE OF IMAGES An infrared camera captures the temperature of a system of numerical spreadsheet that is instantly converted by a software, thermal imaging, which can be demonstrated in the form of various scales colorimetric (pallets) according to the best resolution and contrast for each situation. Each color represents an isotherm and selected images will be highlighted and analyzed using an image processor specific. (Brioschi et al., 2010).

The operator should preferably be familiar with the camera to use its resources as well as image capturing, recording and adjustments.

In the analysis of thermographic examination of endothelial uptake should be performed in three steps.

- Step 1 - Immediately after the cooling of the patient
- Step 2 - During the compression arm (ischemia phase)
- Step 3 - After the compression arm (phase of reactive hyperemia)

All capture and storage of thermographic images should be done so within 5 minutes of continuous Step 2 and Step 3 of 5 minutes.

INTERPRETATION OF RESULTS: The thermal variables considered in the study for the purpose of assessing endothelial function are (1) temperature and rebound (2) neurovascular reactivity index (NVR). A change in any one of the two variables identifies changes in endothelial function.

The temperature difference between the rebound and the highest temperature on the front of the hand subjected to compressive period before ischemia (basal end) and the highest temperature in the same hand within 5 minutes after the end of the tourniquet time of reactive hyperemia. It is considered normal response (absence of endothelial dysfunction) when the difference equal to or greater than 0. (Maximum temperature in reactive hyperemia - baseline maximum temperature>0).

This phenomenon is expressed in a graphic drawn up markedly in cases of absence of endothelial dysfunction and absence of this type of curve in endothelial dysfunction.

The neurovascular reactivity index (NVR) evaluates the effect of the sympathetic autonomic nervous system (ANS) in response to ischemia. The activation of the sympathetic in the case of an ANS ischemic process is a physiological phenomenon but their hyperactivity, adrenergic or exacerbation is linked to endothelial dysfunction.

The NVR is obtained by measuring the maximum temperature in the hand control (contralateral, one that was not subjected to compression arm) during the baseline period (Step 1), ischemic compression (Step 2) and reactive hyperemia (Step 3). Findings are considered normal when there is an increase in contralateral hand temperature during compression of the brachial artery occlusion and during reactive hyperemia, with values of temperature at or above the baseline in this hand.

Are four possible types of results according to the type of thermal response.

They are: 1 - A flow-mediated response inadequate, or reflects an inability to release sufficient nitric oxide (NO) by the endothelium against ischemia induced or a

2 - adequate response to flow-mediated NO reserve sufficient enough to promote vasodilation and increased temperature at the end of the finger that was under ischemia.

According to the neurovegetative reflex sympathetic response in the contralateral hand (control).

3 - This can be changed (no temperature rise) by activating the sympathetic autonomous nervous system, and

4 - normal (higher temperature of the contralateral hand during and after the compression arm). Anyway, answers 1 and 3 are interpreted as endothelial dysfunction.

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SAO PAULO UNIVERSITY HOSPITAL THERMOGRAPHY PROTOCOL FOR PERIPHERAL ARTERY DISEASE

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Thermography is a complementary non-invasive diagnostic with minimal discomfort to the patient with peripheral arterial insufficiency of the lower limbs. It should monitor atherosclerotic changes, map and measure the perforating arteries, identify sites where there may be inflammation, formation of tumours by an abnormal increase in vascularity, or abnormal vessel reaction to cold stimuli in peripheral arteries.

DEVELOPMENT OF A CLINICAL VASCULAR OPTICS MEASUREMENT FACILITY

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The microvascular diagnostics service based in Newcastle upon Tyne provides a comprehensive array of mainly optical and thermal technologies which are utilised to access micro-circulatory blood flow and function. These vascular optical techniques include thermal imaging, capillaroscopy, laser Doppler imaging and flowmetry, tissue spectroscopy and multi-site Photoplethysmography. The test portfolio covers four main areas: Connective Tissue Disease and Raynaud's Phenomenon Assessment, Specialist Limb studies (i.e. amputation level, muscle compartment perfusion and venous physiology), Neurovascular Assessment and Burn Depth Assessment. The measurement service at Freeman is greatly benefiting from a new state-of-the-art purpose-built temperature and humidity-controlled room, enabling investigations to be performed efficiently and with confidence. The rooms special air conditioning system can also be programmed to rapidly shift operating conditions between cold (e.g. 15°C) and hot (30°C) ambient temperatures for whole body thermal physiology assessments. Development project work is also undertaken; including microvascular endothelial function assessment, novel assessments in Chronic Fatigue Syndrome/ME, multi-site photoplethysmography, fluorescence spectroscopy in scleroderma, and thermoregulation in Restless Legs Syndrome. The measurement facility forms a unique clinical measurement and research resource. The development of the facility, routine clinical services offered, and research work undertaken will each be summarized.

THERMOGRAPHY AND COLOUR DUPLEX ULTRASOUND ASSESSMENTS OF ARTERIO-VENOUS FISTULA FUNCTION IN RENAL PATIENTS

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Vascular and clinical assessments of arterio-venous fistula function are important in patients undergoing or preparing to un-

dergo renal dialysis. Objective assessments at Freeman Hospital now include combined colour duplex ultrasound and medical thermography measurements. For example, these modalities can help study problems relating to either fistula failure or to excessive fistula flow which can result in vascular steal (finger blood flow impairment resulting in skin temperature reduction). The aims of this study were to investigate the relationship between fistula region skin temperature and fistula blood flow using manual and automatic image temperature extraction techniques.

Patients underwent objective vascular measurements which comprised thermal imaging of the fistula region followed by fistula blood flow estimation using colour duplex ultrasound at the brachial artery. Temperature measurements were collected using a FLIR SC300 infrared thermal imaging system (spectral range 7.5 to 13.0 μm) fitted with its standard 24o viewing lens. Skin emissivity was assumed to be 0.97. Differences (fistula - non-fistula side) in fistula region temperatures were determined using a) manually extracted measurements and b) measurements calculated using an automated image processing procedure based on global thresholding and region growing. Temperature readings from the regions of interest were then compared with fistula blood flow and the correlation coefficients calculated. Differences between manual and automatic techniques were tested using Student's t-test.

Fifteen patients were studied (mean age 60 years). Estimated fistula flows ranged from 30 to 1950 ml/min (mean [standard deviation] of 920 [680] ml/min) and were significantly correlated with bilateral differences in maximum fistula region skin temperature for manual and automatic techniques (Manual $R=+0.71$, $p<0.01$; Automatic $R=+0.73$, $p<0.01$), each demonstrating an association between fistula region skin temperature and estimated fistula blood flow. There were no significant differences between the manual and automatic temperature extraction techniques, with mean (standard deviation) differences (manual - automatic) of +0.02 (0.28) oC ($p=0.8$). Further work is now needed to explore the clinical utility of these findings, and also to examine the detailed characteristics of the fistula thermal profiles.

SAO PAULO UNIVERSITY HOSPITAL THERMOGRAPHY PROTOCOL FOR VARICES.

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Infrared thermography is based on analysis of skin surface temperatures as a reflection of normal or abnormal human physiology. Traditionally evaluation of skin temperature has been studied using systems involving one or more single point measurements, such as with thermocouples. It is only since the availability of infrared imagers, that efficient non-contact temperature recording has become possible. In a fraction of a second, a large area of the human body can be imaged with a thermal resolution approaching 50 mK as well as a spatial resolution of 25-50 μm, and dynamic responses to stimuli are easily documented. Thirty years of clinical use and more than 8000 peer-reviewed studies in the medical literature have established thermography as a safe and effective means to examine the human body. Today, infrared thermal imaging has become one of the most efficient techniques for the study of skin temperature, in which modern infrared digital cameras, employing advanced focal-plane array technology, provide a sensitive diagnostic tool for a multitude of clinical situations, ranging from breast cancer screening to open heart surgery. The indications of thermography in the study of varices are marked: knowledge of extension of disease, analysis of complications, therapeutic response, epidermal or iatrogenic changes, mimetism of the course for the surgeon, indication and delimitation of the map skin for the surgeon. Also the advantages of thermography: simplicity, innocuousness, reproducibility, objectivity, possibility of dynamic studies, possibility of knowledge of the disease without the introduction of devices or irritative response of other procedures, safety, lack of pain, low running cost. In the study of the lower extremities the following projections have been used: anterior, posterior, medial, lateral; it was possible to obtain in a photogram the lateral out face of one extremity and the medial of the other with one foot forward from the other. For the analysis of the abdominal wall circulation, use has been made of frontal projection and both obliques. The lower extremities are shown in the normal thermogram as cold zones, except at the level of the popliteal, caval and inguinal region where there is slight physiological hyperthermia due to an increase in infrared reflexion. In the thigh and leg and varying greatly from one person to another, one can see trajections of hyperthermia of some two degrees, linear in form, and which correspond with the superficial venous system. The abdominal wall in normal conditions does not show vascular trajections in young individuals; on the other hand, in globular abdomens some trajections can be seen in both voids and suprapubic region. In the essential varices the findings can be thus synthesized: Marked lineal hyperthermia in correlation with the dilated venous trajection, the gradient of which varies from 3 to 6 °C with respect to the other member. In the majority of cases, the system affected. Is that of the internal saphena. The externa saphena is affected in approximately 10 % of the cases, both systems are infrequently. Varicophlebitis is a complication most frequent in thermographic exam. The ulcerous complication is reliable in termography and this is very good for estimating the involution. Althought difficult, oedema, eczema and hypodermitis also are identified by infrared imaging.

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CAN DYNAMIC INFRARED THERMOGRAPHY (DIRT) BE USEFUL IN FREE PERFORATOR FLAP SURGERY?

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With the advent of perforator flaps a new era started in reconstructive surgery. A perforator flap can be defined as a flap of

skin and subcutaneous tissue, which is supplied by an isolated perforator vessel. The use of perforator flaps to close defects due to trauma, pressure sores, ablative surgery for cancer, and infection is now frequently reported. The main advantage of perforator flaps is their low donor site morbidity. The majority of donor sites can be closed directly and, as the underlying muscle and its nerve supply are preserved, donor site morbidity is minimal. Studies also suggest faster recovery, less postoperative pain and shorter hospital stays with the use of perforator flaps compared to the use of their musculocutaneous counterparts. The disadvantages of perforator flaps are largely related to the learning curve. In the preoperative phase there is a need for adequate planning which includes selection of a suitable perforator that can provide adequate perfusion of the flap. During perforator flap surgery, dissection of the selected perforator requires a meticulous technique as vasospasm or damage to the perforator can lead to impaired flap perfusion or even flap loss. As the perforator is not protected by a muscle, cuff torsion, kinking or external compression during flap inset can easily occur. As with all free flap surgery, survival of the free perforator flap relies on patency of the arterial and venous anastomoses. A thorough understanding on the physiology of the dynamics of flap perfusion is a large advantage. In this respect the use of dynamic infared thermography (DIRT) in the preoperative, intraoperative and postoperative phase has shown to be able to provide the surgeon with valuable information on flap perfusion that can help to improve flap survival of free perforator flaps. In contrast to capturing static thermal images, DIRT involves capturing sequences of images to analyse changing thermal patterns in the skin over time. By applying a thermal challenge, for example a fan cooling, the subsequent recovery of the skin temperature toward its thermal equilibrium is evaluated with respect to rate and pattern of recovery. A special form of DIRT is reperfusion of tissue after completion of an anastomotic procedure. The usefulness of DIRT in free perforator flap surgery will be illustrated using autologous breast reconstruction with a deep inferior epigastric perforator (DIEP) flap as an example.

ADVANCED MODELING IN THERMAL IMAGING AND ITS APPLICATIONS IN DIAGNOSTICS.

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In this study we used Control System Theory to model cutaneous thermoregulatory processes in response to a standardized cold challenge, a diagnostic test routinely performed, for example, for differential diagnosis of Raynaud's Phenomenon or hyperthermia secondary to varicocele. The proposed model is based on a homeostatic negative feedback loop, characterized by five distinct parameters, which describe how the control mechanisms are activated and maintained. The proposed approach has been applied to thermal infrared imaging data from 14 systemic sclerosis subjects, 14 PRP, and 16 healthy control subjects (HCS) for studying how the disease affects finger thermoregulation. A second study was performed on 49 young patients suffering from left varicocele and 17 healthy controls. In both studies, the models were able to describe consistently the physiopathology of the disease and provided useful follow up indications.

FUNCTIONAL INFRARED IMAGING IN THE DIAGNOSIS OF RAYNAUD'S PHENOMENON.

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Infrared Functional Imaging was applied to the study of Raynaud's Phenomenon obtaing a simultaneous assessment of the thermal properties of all five fingers of both hands of a group of patients with respect of a control group. The method is based on the use of high-resolution telethermography imaging and allows identification of objective parameters from the re-warming curves of finger immediately after a 2 min cold stress. A series of mathematical and biophysics parameters could be evaluated by the modeling of the recovery curves, obtaining figures particularly effective in describing the thermal properties of the finger.

18 healthy volunteers, 20 Secondary Scleroderma and 20 Primary Raynaud's Phenomenon patients were studied subsequently to clinical evaluation and nailfold capillaroscopy. This new approach highlighted a quite different behaviour between patients with Primary Raynaud's Phenomenon and those with early diagnosed Systemic Sclerosis This new method, compared with other existing techniques, seems to be useful tool for the early discrimination and differential diagnosis between PRP and RP secondary to Ssc.

NEUROSURGERY

INFRARED THERMOGRAPHY USE AT COMPLEX REGIONAL PAIN SYNDROME.

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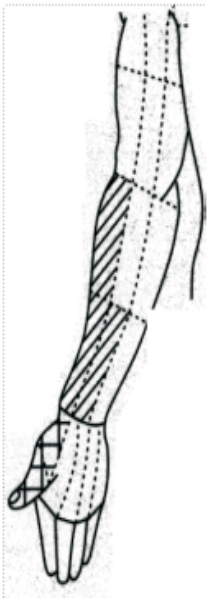
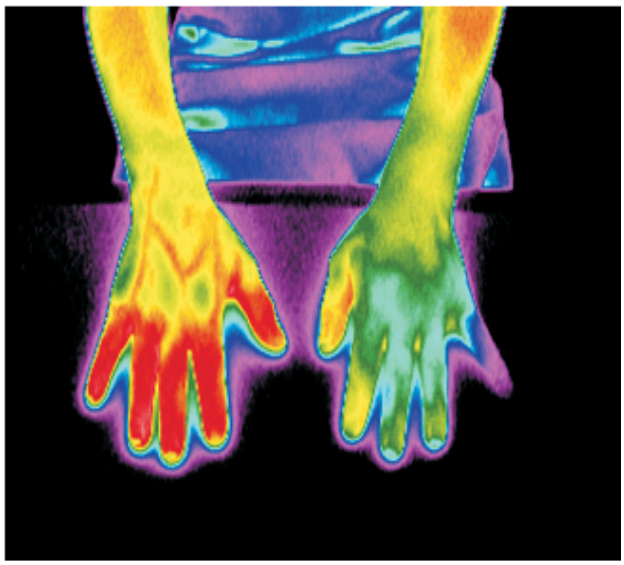
Complex regional pain syndrome (CRPS) is a potentially disabling neuropathic condition characterized by regional pain that is often disproportionate to or occurs in the absence of an indefinable inciting event. CRPS involves inflammatory, neuropathic and nociceptive mechanisms. It is always associated with abnormal sympathetic nervous system activity that includes a characteristic triad of autonomic, sensory and motor disturbances. Results of validation studies have shown significant potential to failed diagnosis due to low specificity, low inter-observer reliability, and considerable variability in the recognition of relevant clinical signs. The diagnosis is complicated by neuropathic and somatic conditions that often mimic this syndrome, so complicating the treatment. The functional cold water autonomic stress test by thermography evaluates the integrity (function) of the autonomic nervous system and it is 100% sensitivity and 94% specificity with a kappa index of concordance of 0.69 when comparing patients with the modified IASP criteria for CRPS. In conclusion, functional infrared imaging effectively detects specific IR signature indices that objectively reflect vasomotor instability that are important in establishing a differential diagnosis of CRPS. Functional infrared imaging, when administered and evaluated by a competently trained doctor, is both pragmatically valid and ethically imperative.





THERMATOMAL ALTERATION IN THE CERVICAL DISC HERNIA/ HERNIATION C5/C6: CASE REPORT AND LITERATURE REVIEW

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OBJECTIVE: The evaluation by infrared image on a patient complaining about cervicalbrachialgy on the right side resulting from cervical disc hernia C5/C6.

METHODS: The patient ABMG, 43year-old female, married, Lawyer, originally from Presidente Prudente city, white, had a progressive cervical pain complaint for 3 weeks. Currently intense pain, EVA=8/10, with irradiation toward the right upper limb through the thenar region, thumb and index finger, with paresthesia and gentle loss of the sensibility, the pain aggravation to the strains and bending of the neck and it improves with the local heat and lain position. The neurological examination has shown light weakness of the brachial biceps and carpus radial extensor with hypoactive tendon jerk of the biceps muscle. The compressive cervical radiculopathy is an ordinary clinical problem which reaches adults in all age groups, but it is rare in children and adolescents. The symptoms range from light and chronic to the acute pain with weakness and sensitive alteration. The investigation of the pain generator causes on the cervical region remains challenging. The thermographic exam, with no contrast, painless and it can be used on any person, even on pregnants and children to the painful neuromuscular conditions such as painful myofascial syndrome, myositis, muscle ligament lesions, radiculopathy by cervical disc hernia, complex local pain syndrome and inflammation such as arthritis in the zygapophysis articulations and tendinitis. For the thermographic exam accomplishment, the patient must remain undressed for 15 minutes to equalize its body temperature with the climatized environment at 23°C, 50% of relative humidity and air current <0,2m/s, accomplishing the filming, without any contrast and no radiation. The thermographic examination must include the total body from the front and from the back. Positions for the shoulders, trunk, upper and lower limbs must be taken. It is always important include the contralateral limb due to the principle of the neurovascular similarity between the hemibodies and for calculating the temperature difference between the right and left side (delta T) to the corresponding areas (ROI). The infrared thermal images shown in cases of cervical-brachialgia by cervical disc hernia will appear on the dermatome involved as hyporadiant or hyper-radiant alteration.

RESULTS: The changing thermathomal area on the disc hernia C5C6 was shown in the radial region of the forearm to the thumb and index finger with thermal asymmetry between the upper limbs with delta T considered abnormal from 0.3°C to 1.0°C. According to BENELIYAHU and SILBER (1990) it was found 84% of sensibility and 78% of the predictive value correlated to MRI and thermography in cases of cervical disc hernia.

CONCLUSIONS: The infrared imaging is a non ionizing diagnostic imaging method, that is painless, does not need radiological contrast media and it can be applied at all ages, also in pregnancy. It can be applied for chronic pain evaluation such as in cervical disc hernia.

LEGAL MEDICINE / EXPERT

IDENTIFICATION OF ALTERED PHYSIOLOGICAL STRESS RESPONSE USING INFRARED THERMOGRAPHY MONITORING

Ionildo José Sanches, Marcos Leal Brioschi, Daniel Colman, Eduardo Adrat, Vanessa Andreoli, Jose Vargas.

InfraRedMed - www.infraredmed.org

OBJECTIVES: This work aims at the development of a secure non-contact system to identify people who have an altered physiological stress response through medical infrared thermography analysis. The system can be deployed in areas of high risk of accidents by providing immediate notification of people's stress state being monitored.

METHOD: For the development of thermography computer system, we are using of a standardization methodology of cutaneous thermal readings considering the environmental and central body temperature for medical infrared thermography studies, making corrections in the cut value by means of a adimensional temperature methodology (Brioschi, 2011). The software performs the analysis of the pulsed thermal waveform related to respiratory and heart frequencies of the individual, as well autonomous vasomotor activity related to facial cutaneous flux, which will serve as parameters to quantify the physiological condition of stress response altered. The infrared images acquisitions are made by using a FLIR ThermoVision® A320 infrared camera, with 320 x 240 pixels resolution.

RESULTS: A set of classes were developed to acquire the infrared images, display grayscale and pseudo-color images, image processing and image analysis using the adimensional temperature. Using the adimensional variable ? considers the individual metabolism and environmental temperature at the examination site and to determine the level of stress considering the cut-off values of normality.

CONCLUSION: The computer system will allow, besides the identification of health disorders, also the epidemiological study of environmental factors that trigger these irregular physiological reactions in order to prevent possible accidents during professional risk-taking.

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THERMAL INFRARED IMAGING IN NEUROPSYCHOPHYSIOLOGY: NEW APPROACHES AND POSSIBILITIES

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A novel system that incorporates non-contact and non-invasive physiological monitoring of the human autonomic nervous activity is presented. The autonomic activity is recorded through its effects on cutaneous temperature. The sensing element is a thermal camera that is employed as a computer peripheral. Through bioheat modeling of facial imagery, almost the full range of vital signs can be extracted, including localized blood flow, cardiac pulse, breath rate, and sudomotor response. These physiological informations can then be used to draw inferences about a variety of health symptoms and, more important, psychological states. This research aims to realize the notion of sustained monitoring for emotional states.

ADVANCED MODELING IN THERMAL IMAGING AND ITS APPLICATIONS IN DIAGNOSTICS

In this study we used Control System Theory to model cutaneous thermoregulatory processes in response to a standardized cold challenge, a diagnostic test routinely performed, for example, for differential diagnosis of Raynaud's Phenomenon or hyperthermia secondary to varicocele. The proposed model is based on a homeostatic negative feedback loop, characterized by five distinct parameters, which describe how the control mechanisms are activated and maintained. The proposed approach has been applied to thermal infrared imaging data from 14 systemic sclerosis subjects, 14 PRP, and 16 healthy control subjects (HCS) for studying how the disease affects finger thermoregulation. A second study was performed on 49 young patients suffering from left varicocele and 17 healthy controls. In both studies, the models were able to describe consistently the physiopathology of the disease and provided useful follow up indications.

FUNCTIONAL INFRARED IMAGING IN THE DIAGNOSIS OF RAYNAUD'S PHENOMENON.

Infrared Functional Imaging was applied to the study of Raynaud's Phenomenon obtaing a simultaneous assessment of the thermal properties of all five fingers of both hands of a group of patients with respect of a control group. The method is based on the use of high-resolution telethermography imaging and allows identification of objective parameters from the re-warming curves of finger immediately after a 2 min cold stress. A series of mathematical and biophysics parameters could be evaluated by the modeling of the recovery curves, obtaining figures particularly effective in describing the thermal properties of the finger. 18 healthy volunteers, 20 Secondary Scleroderma and 20 Primary Raynaud's Phenomenon patients were studied subsequently to clinical evaluation and nailfold capillaroscopy. This new approach highlighted a quite different behaviour between patients with Primary Raynaud's Phenomenon and those with early diagnosed Systemic Sclerosis This new method, compared with other existing techniques, seems to be useful tool for the early discrimination and differential diagnosis between PRP and RP secondary to SSc.

HUMAN BEING STRESS LEVEL MONITORED BY IR REMOTE SENSING.

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This paper described the use of non invasive remote passive IR imaging for measurement of human vital signs to detect altered 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 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 dis-

tance. So it is ready to be used at airports, and health screening, police departments, elder care, workplace preventive care, and vehicles dashboards.

THERMAL SYMMETRY OF THE LIMBS IN HEALTHY SUBJECTS

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Infrared thermal imaging is being increasingly utilized in the study of neurological and musculoskeletal disorders. In these conditions data on the symmetry (or the lack of it) of skin temperature provides valuable information to the clinician. In current times the appearance of newer generations of higher resolution cameras a lack of reference data resulting from comparison between total body views with close-up regional views in both anterior and dorsal visualizations existed.

Establish a value for Sagittal and Coronal thermal symmetry of the human body is needed to be used as indicator in clinical assessments.

In this study skin temperature measurements have been carried out using thermograms, of hands 75 healthy volunteers and for other body 39 healthy subjects were imaged. Measurements were obtained from an infrared camera (FLIR A40) using the CTHERM application. A computational analysis application was developed to standardize and optimize the time of analysis. This tool performs thermal image morphing based on anatomical landmarks preserving the temperature values associated with the regions of interest (ROI) and generates statistics about mean temperature, standard deviation of those ROI's.

Sagittal Thermal Symmetry using regional views presented a maximum value for mean temperature of 0.49±0.29°C and standard deviation of 0.28±0.29°C for anterior arms.

Total body views and regional views produced comparable results. However in regional views better results were achieved. Using a high-resolution camera the study achieved better results on thermal symmetry in normal subjects than previously reported. Symmetry assumptions can therefore now be used with higher confidence when assessing abnormalities in specific pathologic states.

THE USAGE OF MEDICAL THERMOGRAPHY AS A COMPLEMENTARY EXAMINATION FOR OCCUPATIONAL CONDITIONS AFFECTING THE UPPER LIMBS

Ricardo Vardasca

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Repetitive Strain Injury and its sub-divisions, such as Hand Arm Vibration Syndrome, are the most common occupational conditions that need an accurate quantitative and objective diagnostic test to aid clinicians in the judgment of the degree of injury and correspondent treatment.

An objective assessing method is needed to provide a permanent evidence record of the degree of injury.

Medical thermography was used with a set of developed objective mechanic provocation tests involving vertical vibration exposure of hands and computer keyboard typing challenge, which were followed by a vascular provocation challenge of the hand. In order to assess the peripheral temperature changes of the hand a computational model was developed and the images standardized and analyzed.

It was possible to discriminate between degrees of injury groups ($p<0.05$) but not individuals.

The proposed method is objective and repeatable, can provide information of the evolutionary stage of the condition. Medical thermal imaging can be used as complementary diagnostic tool to provide evidence of occupational condition affecting upper limbs in support to medical history in medico-legal liabilities.

ATLAS OF DIAGNOSTIC THERMOGRAPHY - FULL BODY POSITIONING

Gladis Reisemberger Galindo, Pablo Oliveira dos Santos, Viviane de Oliveira Fernandes, Ana Paula Costa Christakis

CBES - Brazilian School of Systemic Studies

Infrared thermography also known as cutaneous thermometry is a remarkable diagnostic progress in medicine. Thermal imaging of high resolution detects countless pathologic dysfunctions of great preventive importance or already established diseases. It is a totally non invasive exam without any physical contact. Besides to not beam any sort of radiation is totally painless as well. Therefore it can be used in children and pregnant women without any kind of risk, and it can be repeated as many times as necessary, with no risk or pain for the patient. The infrared imaging is a method that complements even more anatomic findings of current radiological techniques (radiography, ultrasound , tomography and magnetic resonance imaging) because evaluates how the entire body is working, regardless of whether there is a structure alteration or detectable tissue by these exams, due the utmost importance of correct accomplishment of this exam, it will be introduced the positioning manual, in order to standardize a protocol of positioning and thus assisting premature diagnostic, treatment, prognostic and therapeutic monitoring. The positioning depends on the area to be analyzed (region of interest - ROI) basis on the clinical symptoms that the patient reports in the anamnesis, being a complete exam because is made on whole body basis, in orthostatic position, assessing both anterior, posterior and side view of the patient.

ATLAS OF DIAGNOSTIC THERMOGRAPHY - ANATOMIC CORRELATION

Gladis Reisemberger Galindo, Pablo Oliveira dos Santos, Viviane de Oliveira Fernandes Ana Paula Costa Christakis

CBES - Brazilian School of Systemic Studies

The infrared imagenology is the production of digital images by the capture of infrared rays emitted by the body allows to evaluate cutaneous microcirculatory activity by mapping the surface body temperature distribution. It does investigate the thermal nature of structures and/or functional modifications produced by disease in the organism. The results of the exam enables determine the functioning of vascular system and , besides this , the nervous system , muscle - skeletal, inflammatory processes and dermatological conditions, endocrines and oncologic. The exam allows to assess the clinical prognostic and, consequently, to resolve more objectively the medical issues . The Thermo graphic atlas shows the correlation of anatomic - functional images , between vascular anatomy neurological, myofascial and thermal imaging, also indicating the correct positions for a complete study.

DERMATOLOGY / ENDOCRINOLOGY

THERMOGRAPHIC EVALUATION OF PATCH TESTS: THE TWO PATTERNS

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Patch testing is a very useful and very safe tool for diagnosing contact allergy. One of serious pitfall in the patch testing method still remains the risk of irritant response into classification of an allergic hypersensitivity, or to evaluate a week positive response in a black skin.

The main trouble still remains in the lack of an objective evaluation of response. With infrared thermography, we can performed a non-invasive, objective, reproducing and recording instrumental diagnoses, based on the analysis of patch test skin areas. One of the problems encountered in this field, is the very low thermal gradients in case of the clinically positive test and/or the difficulty to evaluate this in dark pigmented skin. To this purpose, we employed the thermostimulation method.

We have selected this thermographic analysis, in order to assembly univocal and peculiar point-of-view, to discriminate and to classify, both allergic and irritant reactions.

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EPIDERMAL SKIN PRECANCEROUS AND CANCER LESIONS AND VIDEO-THERMOGRAPHY: THE HYPOTHESIS OF SKIN FIELD CANCERIZATION

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There is evidence that patients with chronic exposure to UV usually develop skin precancerous or cancerous lesions in photo-exposure areas. This observation, lead to concept of "Skin Field Cancerization": this hypothesis suggests how a tumour area can have an increased probability to become the site of another cancer.

Applied in this peculiar area, Video Thermogrphy, revealed some different patterns about different type of skin cancers; in particular:

- Hot spots with quick thermal recovery time on Actinic keratosis
- Cold spots on site of Basal Cell Carcinomas (BCC)
- A well defined hyper thermal area in which usually arise only pre-cancerous squamocellular lesions, while BCC not responded to this peculiar criteria.

We sustain that - if this preliminary data are confirmed - Video Thermogrphy, could represent a "non invasive in real time method", that may be observe a target "dangerous" area, that could be treated before the arising of "skin cancerous lesions".

INFRARED-IMAGING TECHNOLOGY APPLICATION IN PRESSURE ULCERS

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SITE: This study was developed in the Master Degree Program in Health Technology at Pontifícia Universidade Católica do Paraná.

OBJECTIVE: identify and deliberate on different infrared-imaging technology applications in pressure ulcers.

METHODOLOGY: We performed a bibliographic search at PUBMED, MEDLINE, ISI WEB, SCOPUS research bases to identify papers related to the use of thermography in pressure ulcers during the period beginning in 1970 to 2011.

RESULTS: We found two papers that compared thermography and risk-scale (Braden and Norton`s), and on both papers thermography proved to be an efficient auxiliary method to predict patients and high-risk spot for the development of pressure ulcers. Those studies established as wound pattern temperature differences between the target area and surrounding area of 1.5ºC and 1ºC, in that order. Two other studies highlighted the use of thermography as a method to evaluate the prognostic of the ulcer scarring process, demonstrating that the ones showing lower temperature, in relation to the surrounding skin, tended to heal normally, whereas those that showed a higher temperature evolved with a delay in the healing process. Still, another study indicated that when temperature difference, between the ulcer and surrounding skin, was lower than 1ºC there was a healing delay, but when there was a 2.5ºC-temperature difference healing was normal. In animal samples, two studies presented good correlation with the depth and seriousness of the wound through reactive-hyperemia analysis by means of thermography. We also highlighted studies that used thermography to evaluate the effect and patient reaction in relation to a support surface (mattresses and/or cushions) by analyzing the reactive hyperemia curve and thermal variation mapping in the areas of high incidence of pressure ulcers to help in prevention studies. It can also be applied as a support method to evaluate and adjust stump prosthesis, because studies have shown good correlation of temperature alteration with pressure placed in subcutaneous tissue, thus helping in the prevention of ulcers.

CONCLUSION: Thermography proved to be a complementary method able to quantitatively help in pressure ulcer evaluation, prevention, treatment, and monitoring processes, being, therefore, a promising method in clinical practice.

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AN EXPLORATORY LOOK AT THE THERMAL CHARACTERISTICS OF THE EYES IN PATIENTS WITH THYROID EYE DISEASE

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Thyroid-associated orbitopathy (TAO) is an inflammatory condition affecting the eyes of patients with Graves' disease. It is estimated that the prevalence of TAO in the UK is around 400,000. Treatment can be successful in selected cases and consists of high dose steroids, orbital irradiation and surgery. Choice of treatment is highly dependent on accurate clinical assessment as anti-inflammatory treatments are effective only during the active phase of the disease, while some of the surgical treatments are appropriate only when the disease has become inactive. The clinical assessment of TAO is fraught with difficulties because it is subjective. This pilot study therefore explores the clinical value of medical thermography for the objective assessment of the inflammatory aspects of TAO (such as redness of the lids and conjunctivae).

Fourteen patients with thyroid eye disease were recruited from the regional Joint Thyroid Eye clinic. Eighteen healthy control subjects were also studied for further comparison with the patients. Each was requested to follow a pre-test preparation protocol prior to thermography. Patients also underwent a formal clinical assessment of the eyes to form a quantitative Clinical Activity Score (CAS). The CAS was measured within a day of thermography and gave evidence for whether the disease was likely to be active. Thermograms were collected whilst the patient lay comfortably supine and still on a measurement couch, with measurements performed in a temperature controlled thermal imaging facility under normothermic conditions. The thermal imaging system comprised a FLIR SC300 with close up lens (FLIR type 64/150) allowing the full region around each eye to be assessed in detail. FLIR ThermaCAM image processing software was employed to summarize thermal characteristics in selected regions around the eyes.

There is a range of thermal characteristics observed from the thermograms, and there are key features which separate the inactive and active disease patients. Overall, the preliminary data show that thermographic measurements can pick up areas of inflammation in the patients with active TAO (Figure 1a). In some patients with inactive disease the thermograms were difficult to interpret. Other thermal characteristics were observed, including the blink reflex and lacrimation.

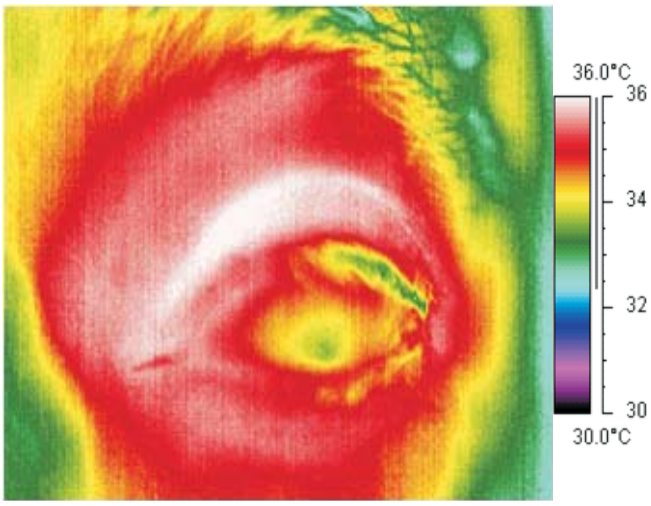

Figure 1 (a) Patient with active disease

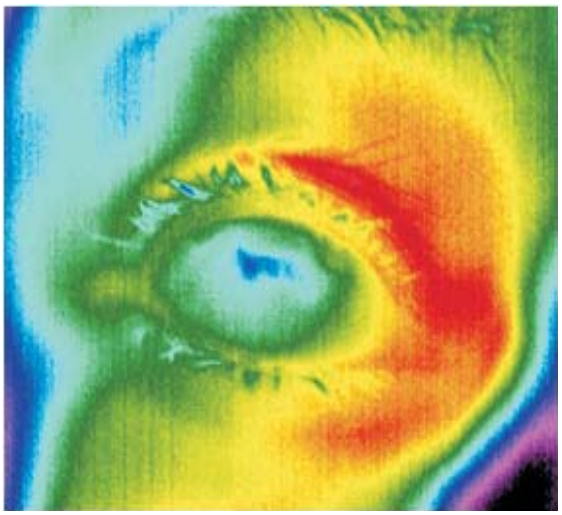

Figure 1 (b) Patient with inactive disease

Further image analysis is now needed to better understand the relationships between the constituents of the CAS score and the complex thermal characteristics of the eye, and the diagnostic accuracy of classifying active disease assessed in a larger patient group.

THERMOGRAPHY, FOOD ALLERGY, FIBROMYALGIA AND ENVIROMENTAL MEDICINE.

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Allergy in its original meaning is of any individualized reaction to any environmental substance occurring in time. Among the multiple environmental causes of inflammatory diseases and painful syndromes, we can find food late allergy (FLA). It is related to food reactions that are not mediated by immunoglobulin IgE, therefore, not constituting an anaphylactic allergy. Such reaction can take place by mechanisms mediated by IgG and other with similar properties such as cationic protein. This type of allergy is easily detectable when a clinical method of exclusion and challenge is used to detect the suspect allergy. The patient is asked to exclude certain foods for 4 days, and on the fifth day, the excluded food is reintroduced, via oral as practice by British School; or subcutaneous as practiced by American School of Environmental Medicine.

The infrared medical thermography allows the observation of inflammatory effects of hollow digestive systems and reflects on

the skin, throughout the increase of infrared radiation on the abdominal region, resulting in a vasodilatation of vessels in response to the nerves stimulation from digestive organs. This skin neurovisceral reflex could be augmented by the inflammation process developed by food allergy reaction.

For practice of environmental medicine is necessary to follow tree steps: 1) where does the inflammation take place? What are the mechanisms that support it? What are the environmental factors which caused inflammation?

In patients with chronic and generalized pain (such as fibromyalgia) the discovery that digestive system is also affected can be decisive, suggesting the origin of the inflammation, determines the disease.

The case we are presenting in the congress is a patient who had pain all over her trunk. It is 25 year-old woman, dentistry with herniated intervertebral disc previous diagnosis. She suffered for 2 years without sustained solution. She was submitted to a thermography and was found inflammation in the upper abdomen associated with the thermal mantle sign pattern and cold extremities characteristic of fibromyalgia patients. She was submitted to the 5 food exclusion process and she didn't feel any pain for 4 days. On the fifth day, she did the skin prick test for coffee, cow, milk, wheat, rice and beans. It was found positive reaction for rice and beans. After 4 months of specific food exclusion the patient remains without pain, active; her sleep patterns were back to normal, she went back to work full time and entertains herself as a normal person. Her only treatment was the exclusion diet of rice and beans. She repeated the thermography that was normal.

Thermography showed to be important in the sense of revealing the digestive allergy inflammation, also to evaluate the possible trigger point of the inflammation of the body, pointing to possible food or digestive cause. The diet of exclusion and challenge was decisive to finalize the diagnosis and the final result.

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EVALUATION OF THREE THERMAL IMAGERS FOR SKIN TEMPERATURE MEASUREMENT USING THE LAND P80P BLACKBODY SOURCE AND SPATIAL RESOLUTION TEST OBJECT.

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BACKGROUND:Calibration is defined as establishing a relationship between a measuring instrument and the value of a measurement standard. The importance of thermal camera calibration is often overlooked in medical applications of thermography. Manufacturers' specifications typically claim an accuracy of ±2°C for un-cooled FPA thermal imagers. This value of accuracy would be unacceptable in clinical measurements where it would account for approximately 20% of the range of temperatures encountered. To investigate the performance of modern thermal imagers in practice, we calibrated three un-cooled FPA infrared devices using a LAND P80P Blackbody source with a traceable platinum resistance thermometer standard to verify cavity temperature.

METHODS. We evaluated the FLIR A320G and A40M (320x 240 pixels) and the E30 portable (160x120 pixels) cameras to ascertain the drift after switch on, linearity, stability with varying ambient temperature and uniformity of the devices. We also evaluated spatial resolution for all three cameras using the Glamorgan test object.

RESULTS. Comparison of the camera reading with the black body source between 20 and 39°C showed that the offset of the thermal cameras was considerably less than ±2°C. The offset bias between the readings (PRT temperature minus camera) during the linearity test was found to be 0.8°C (SD 0.7°C), 0.1°C (SD 0.3°C) and -0.1°C (SD 0.2°C) for the A40M, E30 and A320G respectively. The drift in the camera reading after switch on was measured every 15 seconds for one hour and was found to be minimal for both the A320G and A40M, settling to within ±0.1°C after 28 minutes and 10 minutes respectively. The E30 camera initially showed greater fluctuation over 30 minutes, but the discrepancy was reduced to ±0.2°C after 42 minutes and ±0.1°C after 46 minutes. The spatial resolution was, as expected, lower for the E30 than for the A320G or A40M.

CONCLUSIONS. The results highlight the importance of calibration for quality assurance of medical thermography. All cameras performed within specification, but there was considerable difference in offset bias between the three devices. The drift after switch on is an important consideration, although even the portable E30 device showed acceptable stability well within an hour. Modern un-cooled FPA thermal cameras are suitable for clinical measurements provided appropriate quality assurance is in place.