Clinical Temperature Measurement & Thermography
Cardiff International Arena, UK, 2nd May 2007

Abstracts

THE TEMPERATURE OF THE HEALTHY AND INJURED HUMAN BRAIN

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Introduction Knowledge of human brain temperature is limited. Theoretical models of human brain temperature in health predict small differences only, between brain and body temperature. In animals and primates, incoming arterial blood temperature exerts a major influence on the thermal environment of the brain with fluctuations in aortic blood temperature, due to feeding sleeping and arousal, having parallel changes in brain temperature over time. When the brain is damaged e.g. by severe head injury, studies have shown that average brain temperature exceeds body temperature by approximately 1°C and in some cases by as much as 2°C. If brain temperature is measured in critically ill patients, and there are suggestions that this would be an advance in monitoring and management of clinical benefit, how should this 'new' information be interpreted and what, if any, is the significance of brain-body temperature dissociation (positive or negative)?

New developments in non-invasive techniques for absolute brain temperature measurement have been developed using nuclear magnetic resonance-based techniques (NMR) in spectroscopy (MRS) and imaging (MRSI). Using the proton ^{1}H chemical shift of water referenced to the brain metabolite N-acetylaspartate (NAA) our group have acquired absolute brain temperature in a number of single voxels, to show the temperature distribution within a region of interest. Now, with invasive and non-invasive techniques available for use in man, and alongside other imaging techniques and clinical measurements, it is possible to study human thermoregulation in the brain-damaged patient, the goal being to understand the physiological and pathological responses to a rise in temperature.

The aim of this short review is to discuss the techniques of brain temperature measurement in man, the potential disadvantages of using body temperature 'surrogates' of brain temperature and the controversies surrounding, and the implications of, variability in the brain-body temperature gradient in the damaged brain.

DEVELOPMENT AND VALIDATION OF MICROWAVE RADIOMETRY FOR NON-INVASIVE INTERNAL THERMOMETRY AND ITS POTENTIAL MEDICAL APPLICATIONS

A P Levick 1 D V Land 2, J W Hand 3

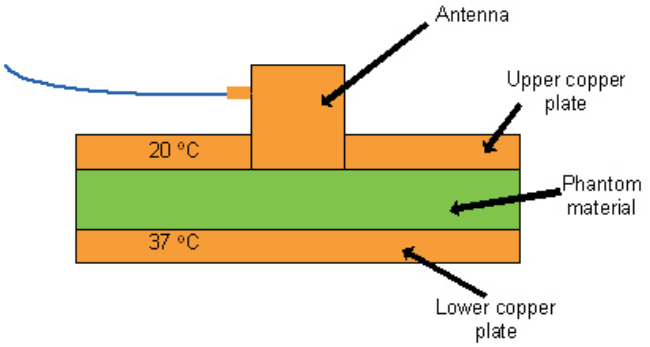
1 Thermal Metrology, National Physical Laboratory
2 Department of Physics and Astronomy, University of Glasgow)
3 Division of Clinical Sciences, Imperial College, Hammersmith Hospital

Microwave radiometry offers a non-invasive method of measuring the *sub-surface* temperature of a wide range of lossy dielectric materials such as foods and human tissue. It measures the temperature dependent intensity of natural Planckian thermal radiation emitted by a material over a band of frequencies in the microwave region. In the microwave region of 1 GHz to 4 GHz, the materials of interest are partially transparent to electromagnetic radiation, allowing the radiometer to measure temperature within the material over a depth of several centimetres. This technique has been developed by several research groups over the last 25 years and applied to a variety of medical and food processing applications. One particular application that has gained considerable interest recently is hypothermic neuroprotection therapy in neonatal babies with hypoxic-ischaemic encephalopathy. Hypoxia-ischaemia affects 2 per 1000 babies, and approximately 1000 babies per annum in the UK could benefit from neuroprotection therapy for which microwave radiometry may provide a non-invasive control technique.

At the National Physical Laboratory (NPL), we have quantified the performance of microwave radiometry by carrying out measurements with two test targets:

(1) An isothermal target that allowed the uncertainties to be measured for microwave radiometers operating as basic thermometers. The noise, flicker and drift levels were determined using the Allan variance statistical method for two radiometers of very different design developed at Glasgow University and Hammersmith Hospital respectively.

(2) A linear temperature gradient phantom target allowed microwave radiometry assessed for its ability to measure sub-surface temperatures. The figure below is a schematic diagram of a linear temperature gradient target comprising a volume of "phantom tissue material" with known dielectric properties sandwiched between two copper plates at different temperatures. The plates are temperature controlled by water circulation using closed-circuit water baths. A nominally linear temperature gradient is thus established across the phantom material. The microwave radiometer antenna is coupled to the upper and central surface of the phantom material volume. The target simulates the superficial layers of a baby's brain in which the upper face of the sample represents the skin surface and the lower surface corresponds to the brain core.



MRI THERMOMETRY FIXED-POINT VALIDATION TARGET

Rob Simpson, Andrew Levick

National Physical Laboratory, Teddington, Middlesex, UK,

Magnetic Resonance Imaging (MRI) thermometry provides a unique means of mapping internal temperature and is performed using a number of methods including T1 relaxation, molecular diffusion and proton resonance frequency shift. Such a map can provide useful information for many thermal therapies such as laser, RF, ultrasound and hypo/hyperthermia, enabling close treatment control and analysis. All of the methods however suffer from drift causing significant uncertainty in the absolute temperature.

The National Physical Laboratory (NPL) has conceived and developed a novel fixed-point validation target for MRI thermometry. This fixed-point target provides a stable reference source of accurately known temperature for validating and calibrating MRI thermometry. The prototype consists of an ethylene carbonate fixed-point cell with a phantom material cavity located at its centre. The fixed-point cell provides a stable (within ± 0.01 °C), repeatable (within ± 0.03 °C) near body temperature source for nominally 3 hours. This paper describes the design, testing and validation of the system including some provisional results from field trials.

DEVELOPMENT AND LABORATORY TRIAL EXPLORING USE OF INFRARED ENDOSCOPY DURING ENERGISED SURGICAL PROCEDURES

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Objective: A novel infrared endoscope has been developed to monitor thermal spread and collateral damage in real time during energized laparoscopic surgery.

System and Method: The infrared endoscopic system consisted of an endoscope measuring 10 mm in diameter and 30 cm in length. The endoscope is directly coupled to an advanced Cedip mid-infrared (3-5 μm) thermal camera, which has a focal plane array of 320 by 240 pixels, and a thermal sensitivity of 0.02°C.

The system was evaluated in a standard laparoscopic surgery trainer with the aim of detecting thermal spread during laparoscopic energised dissections. Cutting and coagulation procedures were conducted on pig stomach using HF electrosurgery, AutoSonix scalpel and LigaSure vessel sealing system. Digital and thermographic videos were taken for advanced thermal analysis and image processing.

Results: During the energized cutting and coagulation experiments, thermographic measurement showed that the average thermal spread was 4.2 mm above 45°C with the LigaSure, and the exposed instrument surface at the tip developed a temperature of approximately 100°C. The LigaSure Atlas 10 mm laparoscopic device exhibited a superior performance with only 2.3 mm thermal spread and with a maximal temperature on the jaws well within tolerable limit 35°C. The AutoSonix dissection device caused a bigger thermal spread of 5.3 mm. During HF electrocoagulation temperatures reaching 275°C were observed.

Conclusions: The study has confirmed that infrared laparoscopy is able to monitor thermal profiles in tissues during energised dissections in real-time. It thus has the potential to increase the safety of laparoscopic dissections when used as an adjunct to white light laparoscopy.

IMAGE PROCESSING TECHNIQUES FOR THERMAL INFRARED IMAGING - AN OVERVIEW

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Reduced costs and improved camera technology are among the factors that led to an increased interest of thermal infrared imaging in medicine in recent years. Thermograms are captured in an automated way and stored in digital form. While in other medical fields various digital image processing techniques are commonly used to assist clinicians, in medical infrared imaging this is often not the case and diagnosis is hence dependent solely on the expertise of the clinician involved when viewing the thermogram(s) on screen.

The aim of this contribution is to provide an overview of image processing methods that have or can be applied to thermograms and covers techniques such as image thresholding, segmentation, tracking, registration, and feature extraction.

THE CHALLENGE FOR THERMOGRAPHY IN FEVER SCREENING OF AIRPORT PASSENGERS

Francis J Ring,

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The SARS outbreak in S.E. Asia in 2002/3 prompted several local health authorities to assemble a number of thermal imaging systems for installation at airport terminals. Not all the cameras used were of proven radiometric standards, and the manner in which they were employed was highly variable. Some were ceiling mounted to view a cohort of passengers up to 30 in number. On the premise that facial temperatures in excess of 38^0C were classified as fever, a number of subjects were sent for clinical examination before being cleared for travel. In a few weeks some 30million travellers were claimed to have been screened in China in 8 weeks, from which approx.9,000 had raised temperatures, 38 were SARS suspects and 21 were ultimately diagnosed.

The technique and the equipment were employed in a manner that would at best give a minimal chance of success. Following a more critical employment of the technique in Singapore, the SPRING Standardisation Dpt. published two guidance documents (TR15 2004) to improve the specification and method of employment in future epidemics.

The International Standards Organisation ISO has appointed a working group to prepare a new version of the SPRING documents for International use, defining a screening thermograph. IEC TC/SC62D – ISO/TC121/SC3, *Clinical thermometers, writing group on thermography for human temperature screening*. This group has now met on four occasions since December 2005, and has a document that is moving into its final stages later in 2007.

There are a number of problems in this area; not least the lack of high quality peer reviewed studies on temperature screening for fever, and the more demanding technical specification of the imaging devices to discriminate between hot subjects and those with genuine fever.

Some practical work is being undertaken on fever detection in children in Warsaw where the author has access to some of the latest thermal imaging technology in a paediatric clinic. The aim is to investigate the relationship between facial, axillary and aural temperatures in normal and febrile children between 1 year and 16 years of age. To date some 95 children have been examined. Results to date indicate that the inner canthi of the eye are reliable targets for temperature measurement, and when this area is over 38^oC, other thermometric measurements confirm the presence of fever.

The outcomes of the ISO committee, the definitions involved, and the preliminary results from febrile and non febrile subjects

will be presented. It is anticipated that the standard and advice documents arising from this work, may well lead to a further standard for clinical thermography.

The need for standardised image capture, using an imaging system with good stability and calibration standards are highlighted in the screening application. The same conditions, with suitable quality assurance checks apply in clinical thermography, with improved reproducibility. This in turn, can improve the acceptability of the technique as a non invasive and objective measure of skin temperature in health and disease. The screening thermograph to meet the new standard is to be considered a medical device. If a Clinical standard follows, it will also be based on a medical device, which will be a change of practice from the current situation where many thermal imaging devices used in medicine are primarily built for industrial applications

FACIAL THERMOGRAPHY IS A SENSITIVE AND SPECIFIC METHOD FOR ASSESSING FOOD CHALLENGE OUTCOME

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Rationale: Oral challenge is the gold standard for diagnosing food allergy but outcome requires interpretation by observers, which may cause error when symptoms are mild and/or subjective. Facial thermography was evaluated as a novel, objective and sensitive indicator of challenge outcome.

Methods :Eighteen children with egg allergy underwent oral egg challenge. Facial temperatures were measured using thermography at baseline and 10min intervals throughout. The difference between mean and baseline temperature (ÄT), maximum ÄT during challenge ($ÄT_{max}$), maximum ÄT during first 20min ($ÄT_{max20}$) and area under curve of ÄT against time (ÄTAUC) were calculated for predefined nasal, oral and forehead areas, and related to challenge outcome.

Results: There were 9 positive and 9 negative challenges. Nasal ÄTAUC and $ÄT_{max}$ were respectively 8.1 and 3.3 fold greater in positive compared to negative challenges ($p<0.05$). In all positive challenges, nasal temperatures showed an early transient rise at 20min, preceding onset of objective symptoms (median 67min). There was a sustained temperature increase from 60min, reduced by antihistamines. A rise in nasal temperature of 0.8°C in the first 20min predicted challenge outcome with 88% sensitivity (PPV 100%) and 100% specificity (NPV 89%) $p<0.05$.Subjective symptoms predicted outcome with sensitivity 11% and specificity 67%.

Conclusions: In the subjects studied, facial thermography consistently highlighted the early onset of significant nasal inflammation during positive compared to negative oral food challenges, evident before objective symptoms occurred. Subjective symptoms did not predict food challenge outcome. Therefore, thermography may offer a sensitive and specific method for determining food challenge outcome, providing new insight into food reaction pathophysiology.

MULTI FIXED-POINT THERMAL IMAGE CALIBRATION SYSTEM

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[4]University of Dundee, Dundee, UK

Clinicians practicing medical thermography utilise thermal imagers as a means of patient diagnosis and monitoring. This work involves the analysis of thermal images, including the periodic intercomparison of assessment images of the same patient and of like patients both in-centre and cross-centre (nationally and internationally). When image intercomparisons require an absolute comparison of measured temperature it is critical that the thermal imager is providing a traceable calibrated temperature. This is usually achieved through regular accredited imager calibration. If not, the comparison will be open to significant measurement risk and uncertainty.

The NPL has developed a multiple fixed-point blackbody system for the in field-of-view calibration of thermal images. The system consists of three fixed-point sources gallium-zinc (25.3 °C), gallium (29.8 °C) and ethylene carbonate (35.9 °C) with repeatability of 0.1 °C. This paper describes the design, testing and validation of the system including provisional results from clinical field trials.

EVALUATION OF TEMPERATURE CHANGES IN HANDS AFTER COLD CHALLENGE

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Immersion of hands in water of 20°C is a well accepted cold challenge test for the thermographic diagnosis of Raynaud's phenomenon. However, a standard for evaluation of temperature changes is not yet established. Francis Ring has proposed a Thermal Index by combining the temperature gradients from the dorsum to the fingers prior and past the cold challenge. Others determined the gradient of single fingers or used the slope of the rewarming curve.

The results of Ring's Thermal Index were compared with the determination of the temperature gradients of single fingers in hands of 26 subjects after cold challenge. The cold stress testtool of the software package C-Therm was used for the calculation of the Thermal-Index. Temperature gradients for single fingers were determined in the following way: Spot temperatures were measured on the tip and over the mid of metacarpal bone of each finger. Gradients were calculated by subtracting the metacarpal temperature from the temperature of the finger tip. The mean value of the temperature gradients of all fingers of the right and the left hand were calculated. The difference of the mean temperature gradient prior and 10 or 20 minutes past cold challenge were compared with the findings of the Thermal Index for the same periods.

Comparison of the thermal index 10 minutes and 20 minutes past cold challenge, obtained a mean decrease of the Thermal Index of $0.32 \pm 1,0$ at the later measurement. The absolute values of the mean temperature gradients were 0,93 to 1,28 greater than the related Thermal Index. However, analyzing both thermal indices with non parametric tests obtained no significant differences between the indices.Single measure interclass correlati ons revealed values between 0.74 and 0.82.

Using a threshold of –4.0 for a diagnostic thermal index, significantly more cases with Raynaud's phenomenon were identified with the thermal gradients than with the C-Therm derived Thermal Index

In conclusion, after cold challenge a high correlation was found between the Thermal Index determined by the dedicated tool of the software package C-Therm and an alternatively calculated Thermal Index based on the temperature gradient of single fingers. However, the Thermal Index derived from the temperature gradients of single fingers may by more sensitive for diagnosis than the Thermal Index generated by the C-Therm software package.

MONITORING TUMOUR DYNAMICS IN XENOGRAFTS VIA THERMOGRAPHy

C Song[1,2], L Campbell[2], V Appleyard[2], K Murray[2], T G Frank[2], B Spruce[2], A. Thompson[2], A Cuschieri[2], W Sibbett[1] PA Campbell[3]

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We tested the hypothesis that thermal imaging might represent a useful adjunct technique in monitoring the presence and dynamic spatial extent of [breast] tumours occurring near to the skin. We also considered the response of tumours to antiangiogenic drugs in animals and in cancer patients. Here we exploit the inherent non-contact and non-invasive advantages of thermography, together with its thermometric accuracy (on presumed thermodynamic 'black bodies') to detect minute skin surface temperature changes. Usually a 1-2ºC increase in skin surface temperature is observed at the tumour periphery, and it has been proposed that this change is due to the hypervascularity and increased blood flow resulting from the tumour-associated angiogenesis. In our study, human tumour xenografts were established in immunocomprised nude mice with MDA-MB-231 mammary carcinoma cells injected. Thermographic investigation was performed continually to detect and monitor tumour growth. It was found that, unlike human breast cancer, no tumour-associated skin temperature increase was observed, but a constant and highly significant decrease 1-2.5ºC was noted, which was independent of tumour size. The explanation for this effect may be due to the exponential tumour growth in mice, and the tumour was just subcutaneous, unlike in human breast which is deeply embedded, convection cooling to the environment may play a major role. Interestingly, smaller secondary tumours, which were unable to be seen by the naked eye, were clearly evident by thermal imaging. Our study indicates that thermographic imaging may have considerable potential in monitoring human tumour xenografts and their response to antiangiogenic drugs.

A THERMOGRAPHIC INVESTIGATION OF PATELLOFEMORAL PROBLEMS

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Introduction: There is some evidence of circulatory disruption in patellofemoral pain syndrome (and . Ben-Eliyahu (1992) suggests vascular disruption at the knee leads to local hypothermia which may be observed through non-contact digital infrared thermography. Few clinical studies have investigated this phenomenon.

Methods: Thirty six patients were recruited from Bolton PCT, Bolton Hospitals NHS Trust and University of Central Lancashire Injury clinic. Modified Functional Index Questionnaire (MFIQ) scores were taken from patients as a clinical measure of their patello-femoral pain. Based on previous research (Selfe 2003), patients were subjectively categorised into 'normal' and 'cold' groups. A thermal washout technique, using a cryo/cuff was developed specifically for this project , to provide a thermal challenge to the symptomatic knee.

Result: Thirteen male and twenty three female patients, age 29.5±11.6 years volunteered. Room temperature was 23.7±1.8 ºC. Twenty four patients were categorised as 'normal', twelve as 'cold'. Modified Functional Index Questionnaire (MFIQ) scores were; 27.5±16.2 for the 'normal' group and 35±22.9 for the 'cold' group (non-significant, p=.264). There was no significant difference (p=.598) between the 2 groups for body fat %; 'normal' group demonstrating 18.3±5.2%, and 'cold' group 17±5.5%. The 'normal' group demonstrated a significantly (p=0.048) higher patella skin-fold measurement; 8.3±2.5mm, versus 'cold' group; 6.2±3.2mm. Ambient room temperature was not significantly different (p=.080) between the 2 groups. Baseline skin surface temperature (T_{sk}), was significantly (p=.046) higher in the 'normal' group than that of the 'cold' group, with temperatures of; 29.6±1.6ºC and 28.5±1.4ºC respectively. This remained true following the 20 minute re-warming period; there was a significant (p=.046) difference between the 2 groups; 'normal' 27.2±1.7ºC and 'cold'; 26.0±1.2ºC.

Discussion: MFIQ scores showed similar differences between groups to those found in a previous study , with the 'normal' group demonstrating a mean score of 33 and the 'cold' group a mean score of 40. Elevated MFIQ scores may be a useful clinical indicator when used in combination with other measures, suggesting the patient has a cold related problem. Body fat % was not significantly different between the two groups, which, may be indicative that; the significantly lower patella skin-fold demonstrated by the 'cold' group (6.2±3.2mm), may be a contributing factor to the symptoms experienced by the 'cold' group; patella skin-fold below 6.2mm may be a characteristic of this subgroup of patients and may serve as a useful clinical measure in identifying these patients. The 'normal' group demonstrated significantly higher T_{sk} compared to the 'cold' group, both at baseline and at the end of the re-warming period, highlighting T_{sk} as another distinctive characteristic of this patient group.

Conclusion: These data support the evidence base that a 'cold' subgroup of patello-femoral pain sufferers exists, and begins to define a clinical profile characteristic to this 'cold' sub-group. These data also confirm the usefulness of a thermal washout technique and thermal imaging in a clinical environment in helping to define this clinical subgroup through developing a combination of useful subjective clinical indicators and objective clinical markers.

THERMOGRAPHIC IMAGING FOR AMPUTATION LEVEL VIABILITY ASSESSMENT: JUST A PRETTY PICTURE OR A QUANTITATIVE TOOL?

D.K. Harrison, L.G. Gaylard , D.B. Singh

Durham Unit, Regional Medical Physics Department, University Hospital of North Durham, Durham DH1 5TW, UK

We have previously described the use of skin oxygen saturation (SO_2) measurements to predict healing viability in lower limb amputations for critical limb ischaemia.[1] The technique involves determining the *degree of tissue hypoxia (DTH)*[1] which is defined as the percentage of SO_2 values along the leg with a value of less than 10%. It was found that if the DTH was less than 15% or the mean SO_2 at two specified sites along the line of a proposed below knee amputation (BKA) was 30% or greater, healing at the BKA level was successful. The technique, using the above criteria and in combination with thermographic imaging[2], has been applied to routine clinical practice in the University Hospital of North Durham since 1999. The results of an initial audit of these techniques was published in 2002[3] and demonstrated a 94% healing rate of BKAs was being achieved at a BKA to above knee amputation (AKA) ratio of 9:2. The quantitative assessment of DTH is the primary criterion that is used to recommend amputation level, and to date temperature gradients in the thermographic image have only been used as a qualitative guide.

During a recent survey of 33 amputations carried out in the 3 year period 2004-2006, not only was the predictive power of DTH re-assessed, but also temperature gradients were measured retrospectively along the limb from the thermographic images. 9 patients were omitted from the audit: 3 died before the operation, 1 had a flexion contracture, and 5 that were recommended a BKA received an AKA on clinical grounds.

Of the 24 patients that lay within the inclusion criteria 2 were predicted for, and underwent, a AKAs, 2 were predicted for and underwent BKAs but needed to be revised to an AKA because of apparent stump ischaemia. The remaining 20 patients were recommended and underwent BKAs that successfully healed.

Analysis of the thermographic images revealed that the difference in the temperature gradients between the AKA and BKA groups over the first 5cm distally was significant (T test, p=0.03) and also that there was a significant difference (p=0.005) in absolute temperatures 5cm distal to the tibial tuberosity between the two groups. However, despite these significant differences, the overlap between the BKA and AKA groups was too great to be able to formulate a predictive tool from the results.

Further scrutiny of the records of the patients whose BKAs were revised showed that in one case the amputation was carried out 2 months after the assessment. However, anecdotally in the second case (amputation 1 week after assessment) the temperature along the limb was the lowest of the entire cohort.

In conclusion, as in the 2002 audit, skin SO_2 remains a robust predictor of healing viability in the critically ischaemic limb. However, it is intended to carry out a larger retrospective analysis of thermographic images to investigate whether there is a critical limb temperature below which a BKA is not viable. This could play a role in improving even further the accuracy of the assessment.

(1) Harrison DK, McCollum PT, Newton DJ, Hickman P and Jain AS; Amputation level assessment using lightguide spectrophotometry; Prosthetics and Orthotics International 1995; 19:139-147

(2) Spence VA, Walker WF, Troup IM, Murdoch G; Amputation of the ischaemic limb: Selection of the optimum site by thermography 1981; Angiology; 32:155-169

(3) Hanson JM, Harrison DK, Hawthorn IE; Tissue spectrophotometry and thermographic imaging applied to routine clinical prediction of amputation level viability; In "Functional Monitoring and Drug Tissue Interaction"; SPIE Proc. Series 2002; 4623:187-194

COMPARING THE EFFECTS OF DIFFERENT THERMAL REGULATION TESTS (COOL AIR STIMULUS VS. COLD WATER STRESS TEST) ON INFRARED IMAGING OF THE FEMALE BREAST

Reinhold Berz, Helmut Sauer

German Association of Thermography and Regulation Medicine

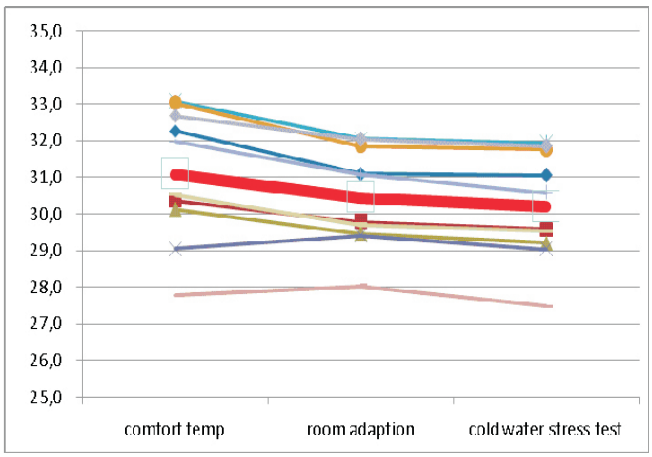
There are different approaches to applying stimulus response tests for thermographic examinations, especially regarding infrared breast imaging, in order to get additional diagnostic or prognostic value.

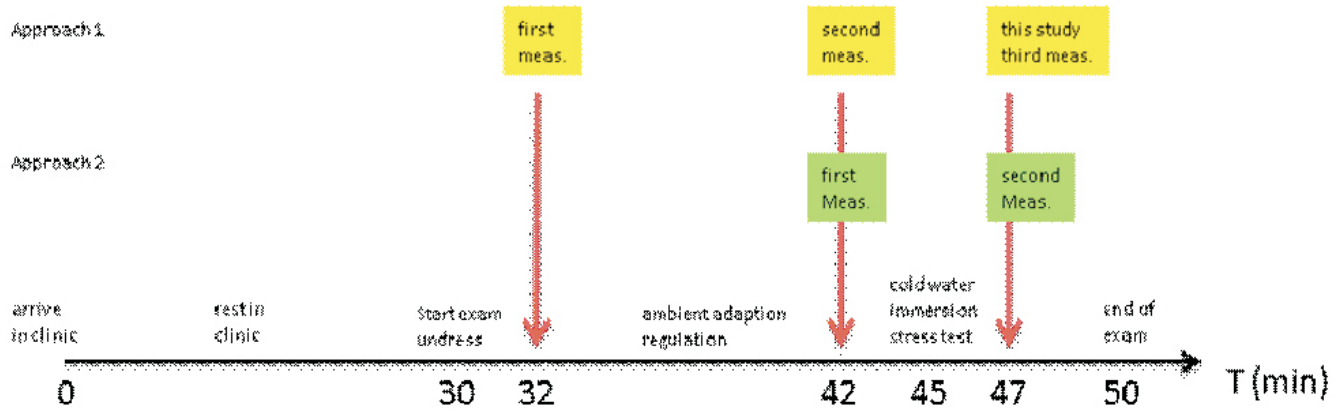
One method (approach 1) is to expose women after undressing to an ambient temperature of 20 °C to 22 °C. The measurement is applied directly after undressing, recording the "comfort temperature". After this the un- dressed subject will adapt to the ambient temperature by a centralization regulation to keep a thermal steady state in the body's core. About 10 minutes after the first measurement, when the subjects have performed this regulation and present a decrease in skin temperature, the second measurement is recorded.

Another method (approach 2) is to wait 15 minutes or longer after undressing before the first measurement is done. After this a cold water immersion stress test is applied (45 to 60 seconds of putting the hands and half of the forearms into either ice water or ice cooled water of less than 10 °C). After this cold water immersion test the second measurement is recorded.

A group of 10 women were examined by MammoVision (infrared breast imaging including regulation tests). Both approaches (1 and 2) were combined and applied in a timeline as displayed in the figure. The infrared measurements have been recorded by a highly precise cooled (-196 °C) infrared scanning camera device (Jenoptik VarioScan High Resolution). Using the MammoVision system it was ensured that exactly the same regions of interest were compared. The statistical evaluation was performed including average, mean, maximum and minimum as well as first and third quartile of the overall temperature of every breast.

Eight of the ten women showed a clear decrease in the median temperature over the breast of 0.9 °C within approach 1 between comfort temperature and adaptation to the room temperature. After the cold water stress test there was only a slight additional decrease (0.2 °C). Two subjects demonstrated paradoxical regulations. One of them showed extremely cold breast temperatures, the other subject was using drugs influencing the blood pressure.





The preliminary results of this explorative study suggest that the additional effect of the cold water stress test usually applied in approach 2 is low and that the contribution of the cold water stress test to additional diagnostic value is limited. Taking into account that the cold water stress test is perceived to be more invasive than just adapting to the room temperature most women would prefer approach 1 as a mild regulation stimulus to be applied.

Further research has to be conducted to establish a scientific based protocol of infrared regulation examinations in order to compare the results worldwide.

Meetings

21st April 2007

Tampa, Florida

Neuromuscular Thermography Update

Location: Embassy Suites, 3705 Spectrum Blvd, Tampa, Florida 33612

Organization: American Academy of Thermology and Tampa General Hospital Rehabilitation Center,
In association with University of South Florida CME office.

Topics::Thermography: History, Guidelines, Physiology, Autonomic Testing., . MRI/EMG Correlation, Animal Model for Pain Research, Recent Developments in Drug Testingm "RSD Look Alikes and Unusual Syndromes", Sports Injury.

Programme Committee:
Bernie Batas, M.D, Gerald S. Goldberg, M.D
Srini Govindan, M.D, Robert Schwartz, M.D

Programme Chairmen:
Robert Schwartz MD, Gerald S. Goldberg, M.D.

Programme coordinator:
Srini Govindan MD

USF CME Coordinator
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Office of Continuing Professional Development, 12901 Bruce B. Downs Blvd, MDC Box 46, Tampa, FL 33612 ,
Phone: 813-974-6237 FAX: 813-974-3217

2nd-3rd May. 2006

IPEM & UKTA Meeting, Cardiff International Arena

Clinical Temperature Measurement and Thermography

2 May 2007

09:00 -09:55 Coffee and registration

09:55 -10:00 Introduction - Dr Diane C Crawford, University Hospital of Wales

10:00 -10:20 The temperature of the healthy and injured human brain - Charmaine Childs, Salford Royal Hospitals NHS Trust

10:20 -10:40 Development and validation of microwave radiometry for non-invasive internal thermography and its potential medical applications - Andrew Levick, National Physical Laboratory

10:40 -11:00 MRI thermography fixed-point validation target - Rob Simpson, National Physical Laboratory

11:00 -11:20 Development and laboratory trial exploring use of infrared endoscopy during energized surgical procedures - Chengli Song, University of Dundee

11:20 -11:40 Coffee & exhibition

11:40 -12:00 Image processing techniques for thermal infrared imaging – an overview -G.Schaefer

12:00 -12:20 The challenge for thermography in fever screening of airport passengers -F Ring, University of Glamorgan

12:20 -12:40 Facial thermography is a sensitive and specific method for assessing food challenge outcome - Jasdip Mangat, Addenbrooke's Hospital, Cambridge

12:40 -13:00 Multi fixed-point thermal image calibration system- Rob Simpson, National Physical Laboratory

13:00 -14:00 Lunch & exhibition

14:00 -14:20 Evaluation of temperature changes in hands after cold challenge K Ammer, Institute for Physical Medicine& Rehabilitation, Hanuschkrankenhaus; Vienna; Austria

14:20 -14:40 Monitoring tumour dynamics in xenografts via thermography - Chengli Song, University of Dundee

14:40 -15:00 Comparing the effects of different thermal regulation tests on breast images- R. Berz, German Association of Thermography & Regulation Medicine

15:00 -15:20 A thermographic investigation of patellofemoral problems - James Selfe, University of Central Lancashire

15:20 -15:40 Thermographic imaging for amputation level viability assessment: just a pretty picture or a quantitative tool? - D. Harrison

15:40 - 16:00 Discussion and Close

DISCUSSION WORKSHOP

This will take place on **Thursday 3 May** at Cardiff Medicentre near the University Hospital of Wales from approximately 9.30 am till 12.30 pm finishing with lunch

Discussion will focus on the following topics:

Standardisation issues for temperature devices and thermal images, New challenges in clinical temperature measurement Thermal mapping on a small-scale (cellular)