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> Gautherie M, HaehnelP, Walter JM, Keith L. Long-Term assessment of Breast Cancer Risk by Liquid Crystal Thermal Imaging. In: Gautherie M, Albert E, editors. Biomedical Thermology. New York Alan R.Liss Publ; 1982. p. 279-301.

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Dermatological applications of thermal imaging

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SUMMARY

This paper presents clinically oriented review of thermal imaging implications in dermatology. For this purpose data collected through Medline and Embase together with hand search in Polish journals, were further selected to comply with interests of a practicing dermatologist. The collected data was organized into six areas of high interest such as oncological, angiological, allergological aspects, skin injury processes, therapeutic regimens and so called "pure" dermatology including psoriasis, herpes, epidermolysis bullosa simplex, alopecia and palmoplantar pustulosis.

Key words: dermatology, skin diseases, thermography, temperature measurement, review

DERMATOLOGISCHER EINSATZ DER THERMOGRAPHIE

Diese Arbeit stellt einen klinisch orientierten Überblick zum Stellenwert der Thermographie in der Dermatologie dar. Zu diesem Zweck wurden in den medizinischen Datenbanken Medline und Embase und in polinischen Zeitschriften nach Publikationen gesucht, die dann nach den Interessen eines praktizierenden Dermatologen ausgewählt wurden. Die so gesammelten Daten wurden nach sechs Bereichen geordnet, nämlich onkologische, angiologische, allergologische Aspekte, Hautverletzungen, therapeutische Regime und so genannte "reine" Dermatologie mit Krankheiten wie Psoriasis, Herpes, Epidermolysis bullosa simplex, Alopezie und palmoplantare Pustulose.

Schlüsselwörter: Dermatologie, Hautkrankheiten, Thermographie, Temperaturmessung, Überblick

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Introduction

Thermal imaging is a non-invasive, non-contact method and therefore finds increasing applications in the clinical medicine including diagnosis and/or differential diagnosis of many pathological conditions, evaluation of disease severity, management planning or monitoring of therapeutic effects including recurrence of the disease and metastases. Generally, pathological processes based on microcirculation changes or inflammation development can be evaluated using thermographic protocols. Because skin is the most easily accessible of all the organs, thus is seems perfectly justifiable that thermography could be more widely used in dermatology. As many dermatological conditions either present systemic features or their further therapy requires specific procedures, thus many specialists are generally involved in the management of a single patient.

Methods

A literature search was performed based on two medical databases i.e. Medline and Embase together with the manual search of Polish medical journals not indexed in available databases using the following keywords: "thermal imaging" or "thermography" or "temperature measurement" in combination with "dermatology" or "skin diseases" or "ulcers" or "varicose veins" or "venous insufficiency" or "Kaposi sarcoma" or "cryotherapy" or "carcinoma" or "naevi" or "melanoma" or "morphea" or "scleroderma" or "lupus erythematosus" or "allergy" or "skin prick/patch tests" or "skin angioma" or "skin burns" or "herpes" or "alopecia" or "pustulosis" or "porphyria" or "sebaceous hyperplasia" or "hyperhidrosis". Abstracts from conferences related to the subject were also included. Subsequently, selection of publications with high interest to a practicing dermatologist was performed.

Results

Dermatological applications of thermography can overlap with some other clinical fields such as allergology, oncology, rheumatology or surgery, so this review should not be treated as an exclusively dermatological. However, the authors have made an attempt not to trespass too much other medical specialitiess but rather to concentrate on those with an implication for a practicing dermatologist in clinical medicine.

Periodically, some authors have presented reviews of thermographic applications in dermatology [1,2,3,4,5,6]. From the practical point of view, this review is divided into six areas viz. oncological, angiological, allergological, skin damaging processes, therapeutic regimens and so called "pure" dermatological conditions.

Oncological aspects

In 1964, Brasfield et al introduced thermal imaging into dermatological practice for the first time and observed increased temperature in malignant melanoma [7]. He described hyperthermic foci in cutaneous malignant melanoma.

Maillard and Hessler observed that malignant melanoma and angioma are particularly hot lesions and thermography could be regarded as an accessory method of diagnosis [8].

Another group investigated the use of thermography in localization of deeply situated malignant tumors and paraneoplastic dermatoses such as dermatomyositis and dermatitis herpetiformis and found it of some value [9].

Brehm and Seeberger did not demonstrate highly significant differences in temperature measurement between different skin tumour types. However, highly vascularized tumours and tumors with inflammatory tissue reactions showed increased infrared emission, while in tumours with increased proliferative activity no difference was found when compared with control values [10]. Ratz and Bailin investigated liquid-crystal thermography in basal cell carcinomas [11]. The authors found out that thermography was useful for neoplasms of moderate to heavy cellular density but was of little help in outlining neoplasms of low cellular density like for example morpheaform basal cell carcinomas [11].

Amalric et al noticed different modifications of hypo- or hyperthermia in malignant melanomas, skin carcinomas, hemangiomas, cutaneous metastases, pre-malignant conditions, burns and radiotherapy lesions thus giving some information on the extension of spread of the lesion and response to treatment [4].

Linderman and Maillard tried to explain the fact that malignant melanomas are particularly hot tumors by the fact that hyperthermy is partially depending on the thermical effects which accompanies the secretion of melanin in these tumors [12].

Bourjat et al also studied the value of thermography in malignant melanomas [13]. Bilynskii et al recommended thermography for early diagnosis of melanoma recurrences and metastases [14]. Diem and Wolf using contact thermography in malignant melanoma conclude that this method can be regarded only as complimentary method of investigation and positive thermograms should lead to a diagnosis of malignancy without being pathognomic of malignancy [15]. Tapernoux and Hessler however only found a correlation in two-thirds of the examined cases between hyperthermia and malignancy [16]. Also, Cristofolini et al very critically evaluated thermography in diagnosis and follow-up of cutaneous malignant melanomas, stating that false negative thermograms accounted for almost 30% which is too high for clinical use [17].Whereas a Russian group pointed out that they found thermography was effective as a screening method for subjects at high risk of malignant disease [18].

Michel et al concluded that malignant melanomas expressing marked local hyperthermia have a particularly poor prognosis [19]. This group were also studying metastatic spread of malignant melanoma and observed a considerable degree of hyperthermic radiation in auxillary or inguinal areas. The authors found a considerable correlation between an increased in the number of macrometastases and the grades of regional hyperthermia [20].

Mikulska et al presented a rare case of eyelid melanoma demonstrating hyperthermic metastatic lesions confined to the patient's chin [21]. This group were also involved in thermographic studies of pigmented lesion evaluation [22, 23]. However, there is still more work is required in order to use this method in clinical practice as a screening tool.

Skin injury

Tamura et al monitored pressure sores development by thermography. The authors observed higher temperature in areas in which decubitus ulcers were either developing or healing. Furthermore, higher temperature distribution was found in the areas of decubitus ulcers than in normal areas [24].

Cole et al used thermography in assessment of hand burns and found this method highly significant in predicting which burns would benefit from early surgery [25].

Liddington and Shakespeare estimated thermography implementation in burn depth and observed that thermography should be performed within 3 days following the injury [26].

Zhu and Xin examined early stages of burn injury investigating 29, 882 values of skin temperature which were subsequently classified and statistically analyzed. The authors concluded that depth of early burn can be objectively and in a non-invasive method detected by infrared thermography [27].

Renshaw and Childs studying acute phase of burn injury by thermography concluded that during the first 16 hours after burn injury, widening of the core-to-peripheral temperature gradient cannot be reliably used as a clinical indicator of inadequate circulating blood volume [28].

Riazantseva et al studying localized thermal burns concluded that deep structural metabolic and morphological disorganization of the erythron peripheral component is a factor of risk of postburn complications [29].

Gottlöber et al investigated radiation ulcers and demonstrated by thermography hypothermic zones with extended inflammatory areas adjacent to the radiation ulcers [30].

Satybaldyev investigated superficial and profound frostbites by thermgraphy and found about 82 to 92% of correct answers of frostbite in hands and feet [31].

Angiological aspects

Harding et al observed significantly increased temperature on infrared imaging in patients with diabetic foot ulcers not only around the ulcer, but in the entire foot [32]. This observation was further confirmed by radiological methods as being early osteomyelitis [33]. These findings were further confirmed by subsequent observations of the authors, who reported that thermography is a non-invasive, non-ionising radiation, cost-effective and sensitive method for the early diagnosis of osteomyelitis [34].

Kelechi et al investigating thermography application in chronic venous insufficiency concluded that elevated skin temperature may be an important nursing assessment parameter to evaluate worsening or impending chronic venous insufficiency complications such as venous ulcers [35].

Hassan et al concentrated on the value of thermography in studying vascularity and vascular changes associated with Kaposi's sarcoma [36].

Loreck et al performed liquid crystal thermography of the hands in the group of 54 patients with systemic lupus erythematosus (SLE) and control groups consisting of scleroderma, rheumatoid arthritis and healthy persons [37]. They observed that thermograms of systemic lupus erythematosus showed features of rheumatoid arthritis and scleroderma. Many patients with SLE presented "a very coloured thermographic pattern" indicating frequent changes of hyperthermic and hypothermic areas in the same thermogram. The authors stressed proximal and spot-like hypothermia in the fingers, which is not observed in rheumatoid arthritis patients but seems to be characteristic for scleroderma and/or SLE patients [37].

Howell et al investigated response to cold challenge of the feet of healthy individuals and patients with primary Raynaud's phenomenon and concluded that mean toe temperature and medial-lateral temperature difference are important indicators of Raynaud's phenomenon in the feet and furthermore cold challenge may enhance the value of these indicators [38].

Merla et al based on evaluation of the area under the temperature versus time curve, namely the temperature integral INT, highlighted a quite different behaviour between patients with primary Raynaud's phenomenon and those with early diagnosed scleroderma [39].

Seifalian et al compared three methods i.e. laser Doppler perfusion imaging, laser Doppler flowmetry and thermographic imaging in blood flow assessment in controls and scleroderma [40]. Clark et al also assessed thermography and laser Doppler imaging in Raynaud's phenomenon, the authors found that results of those methods correlated poorly and they cannot substitute each other [41].

Brenke et al observed typical features of progressive systemic sclerosis i.e. general hypothermia of the hands and localized hypothermic areas together with refractory hyper- thermic areas. In the acral rewarming test reactive vasodilatation after cold stimuli is often not inducible and the significantly retarded rewarming shows a marked local dependence on restricted flow [42].

Birdi et al examined 11 children with 18 linear scleroderma lesions and observed active lesions which were defined as warmer than surrounding skin or opposite limb by 0.5 C [43].

Howell et al. studied thermography in localized scleroderma and reported that this method presented a sensitivity for the detection of active morphea lesions of about 90% and specificity of around 80% [44].

Whereas Martini et al employed thermography in detection of localized scleroderma lesions. The authors retrospectively reviewed 130 thermal images of 40 children with this disease and calculated that sensitivity of this method was 92% whereas specificity 68%. They concluded that thermography seems to be a promising tool when associated with clinical examination in discriminating disease activity especially in lesions without severe atrophy of the skin and subcutaneous fat [45].

Raynaud' s phenomenon has attracted much attention world wide [46,47,48].

O'Reilly et al examined cold challenge responses in primary and associated with scleroderma Raynaud's phenomenon [47]. The authors recon that the technique of quantitative thermography appears promising for measurement of the microcirculation disturbance in Raynaud's phenomenon.

Biernacka-Zielinska et al. observed in a group of 30 children that the initial palm temperature of children with Raynaud's syndrome was lower than in control group and directly after cooling the palm temperature fell by 1.8C, after 4 minutes it increased by 1.5C in healthy children whereas Raynaud's syndrome patients did not reach these values, however there was no statistically significant difference between those temperatures. The authors also did not notice different blood flow between patients with primary and secondary Raynaud's phenomenon [48].

Al-Awami et al have undertaken a very challenging issue concerning the comparison of thermography with scanning Doppler flowmetry however there is still further work to be done in this field [49]. In another study, based on thermography, Al-Awami et al observed that low laser therapy lowers the frequency and severity of Raynaud's phenomenon in patients with primary and secondary Raynaud's phenomenon [50]. Howell et al on the basis of data reviewing of 84 patients pointed out that both baseline mean finger temperature and dynamic response were required for adequate assessment of an individual patient [51]. Cherkas et al further investigated Raynaud's phenomenon by cold challenge test. The authors observed that baseline skin temperature could help to predict the occurrence of Raynaud's phenomenon but is of limited value for classification [52].

Melhuish et al employed hand held infrared temperature scanner in assessment in Raynaud's phenomenon stating that this method provides a comparable results to thermal imaging [53].

Despite much research, Heusch et al recently pointed out that still there was no clinical agreement with respect to methodology for determining the presence of Raynaud's phenomenon and much work in this field continues [54].

Allergy

Acute inflammatory responses obtained in skin test evaluation can be assessed by thermal imaging.

Jarish et al used contact thermography for patch tests in diagnosing contact dermatitis and reported that diagnosis of contact dermatitis was increased by 10% and that this method facilitated the interpretation of patch tests in persons with dark skin [55].

Agner and Serup investigated different irritants in patch tests [56]. Another group observed a good correlation between clinical assessment and thermographic results [57].

Jung et al demonstrated temperature gradient between positive prick tests and the surrounding skin thus indicating that thermography is an objective and repeatable technique in evaluation of skin prick tests [58,59]. This Warsaw group concluded that liquid crystal thermography showed larger areas of skin lesions than those seen visually and by analyzing the size of the wheal and flare, and found they could be at least 9 cm apart from each other [60,61]. Buczylko et al employed thermography for the nasal allergen provocation and demonstrated that difference between thermograms during inspiration and expiration phase in the region of anterior nostrils reached 4.05C [62].

Bagnato et al examined skin prick reactions by thermography and concluded that continuous recording of the skin temperature represented an additional parameter for the quantification of wheal reactions [63].

De Weck et al examined the effect of azelastine on the immediate and late-phase skin reactions using both planimetric evaluation of weal and erythema and a thermographic technique. They reported that thermography had proved to be useful in immunopharmacology [64].

Evaluation of therapeutic regimens

Mustakallio tested individual tolerance to dithranol, used in psoriasis treatment, by contact thermography and observed that this method seemed useful in erythema evaluation when the brown stain, caused by the treatment itself, hampered appropriate estimation of erythema [65].

Forde et al studying erythema after photochemotherapy in patients with psoriasis and eczema failed to demonstrate by thermography clear progressive changes in skin temperature. The authors stress that although thermal imaging can show a dose-response of skin temperature to UV irradiation, the effects of underlying tissues and of day-to-day variation in individual body temperature cause poor contrast and excessive variability in measured skin surface temperature [66].

Moskalik et al noticed that in malignant tumours at the wound stage, after neodymium-laser irradiation, pathological hyperthermia was observed within the hypothermic spot which was very likely to be an indicator of viable tumour cells within the wound and thus requiring a repeated course of laser therapy [67].

Torres et al have made some attempts on tissue temperature measurements during laser irradiation [68].

Troilius et al employed laser Doppler imaging and thermography in evaluation of argon laser in port wine stain perfusion, however the authors concluded that none of the above methods could clearly predict the clinical results of the employed treatments [69]. Nelson et al found thermography useful in evaluation of dynamic epidermal cooling during pulsed laser treatment of port wine stains [70].

A very interesting report comes from the Polish group evaluating post-operatively a girl with Klippel-Trenaunay syndrome who demonstrated that thermographic visualization strictly correlated with the clinical assessment of the postoperative state [71].

Schindl et al performed the first randomized double-blind placebo-controlled clinical trial and demonstrated an increase in skin microcirculation due to athermic laser irradiation in patients with diabetic microangiopathy [72].

Aguillar et al employed thermography to evaluate heat extraction via different nozzles during skin laser therapy [73]. The authors confirmed previous results that wide nozzles induce more efficient heat extraction than the narrow nozzles [73].

Gevatter et al estimated calcitonin actions in progressive scleroderma. Based on thermography the authors have observed significantly shortened rewarming period of the patients' hand after standardized cooling [74]. Kan et al investigated new nitroglycerine treatment in systemic sclerosis and observed increased peripheral circulation in those patients thus concluding that this tape application may improve peripheral circulatory disturbance in those patients [75]. Aragane et al. successfully used thermography for assessment of clinical improvement in one patient with disseminated scleroderma treated with PUVA therapy [76].

Ippolito et al examined action of cyclosporine A in psoriasis based on thermography. This group in psoriatic patients observed constant, initial hyperthermia with precocious thermal recovery in comparison to the healthy perilesional skin and after therapy a prolongation of the thermal recovery time was observed in all of the patients parallel with skin disease improvement [77].

Miyamato and Aramaki found thermography useful in evaluation of topical taurine effects in chilblains treatment and concluded that topical taurine was a useful treatment [78].

Before sympathectomy, Tsai et al observed significantly lower palmar skin temperature than facial temperature by 1.3°C whereas after sympathectomy, thermography revealed significant elevations in temperature mainly of palms, digits and nose. The authors found that the T2 segment is of prime importance to sympathetic innervation to the hand [79].

Luong et al evaluating action of corticosteroids on the skin temperature found temperature differences within the first three hours after application between the skin without and with occlusion. The authors' main interest focused on infrared thermography as a quantitative, non-invasive, continuous in real time method [80].

Lehmuskallio et al investigated action on emollients on facial skin in the cold by thermography. Much to their surprise, test emollients more often had an objectively cooling than a warming effect on facial skin and being statistically considerable risk factor for frostbite of the face [81].

What is left? – "pure dermatology"?

Kapkaev et al based on 27 patients and 28 healthy controls examined thermography for the evaluation of dermato-logical conditions such as erythema exudativum multiforme, contact dermatitis, lichen ruber, alopecias, pityriasis rosea Gibert, sycosis, atopic dermatitis, erythrodermas of different origin, naevi and malignant neoplasias [82].

Toshitani et al employed thermography in evaluation of hair regrowth in alopecia patients. In patients with favorable outcome they observed increased cutaneous blood flow and temperature of the scalp skin [83].

McCarthy et al observed some promising results as regards potential use of thermography protocols in diagnosis of epidermolysis bullosa simplex [84].

Biagioni and Lamley studying patients with herpes labialis observed that thermographic involvement was three to four times larger than the clinical area of involvement and concluded that thermographic imaging may represent a new approach to quantifying disease activity particularly in the subclinical prodromal stage [85]. Further research of this group, performed on 70 patients revealed increased temperature over the symptomatic area during the prodromal stage and concluded that thermography can both recognize the prodomal phase and identify the area requiring drug therapy [86]. Ammer et al studying acute herpes zoster and post-heretic neuralgia, observed thermal asymmetry of the skin in patients in acute herpes and concluded that thermal patterns seem to correlate better with the duration of the disease than with pain intensity [87].

Schartelmüller et al investigated patients with facial paralysis and herpes zoster of the upper branch of the trigeminal nerve and observed a higher proportion of patients suffering from herpes ophtalmicus show elevated temperatures on the affected side than patients with facial paralysis [88].

Asada et al used thermography for pre operative evaluation of tonsillectomy and thus monitored temperature after provocation tests at palmoplantar sites. The authors found significant relationship between the effects of tonsillectomy and the results of provocation tests assesses by thermography. The sensitivity, specificity and efficiency of pro- vocation tests with thermography of detecting a favorable outcome of tonsillectomy were around 75-83% and the authors conclude that this method could become a new indicator of the tests in deciding for the tonsillectomy because of palmoplantar pustulosis [89].

The first literature data using thermography in psoriasis patients both suffering from psoriasis vulgaris and/or psoriatic arthritis, dates back to the early nineteen seventies [90]. Mustakallio introduced contact thermography to study influence of dithranol - which is one of the classical local therapies in psoriasis - staining properties on erythema estimation in psoriasis [65]. Psoriasis and psoriatic arthritis continued to attract attention as regards thermography implementation further [91,92,93, 94, 95, 96,97,98]. In psoriatic patients, Warshaw and Lopez after a cold challenge observed that the majority of them did not react to decreased temperature by immediate drop in temperature of the limbs in contrast to the healthy people [99]. Maleszka et al reported that the skin lesions covered with scales seemed to be hypothermic because excessive scales (hyperkeratosis) acted as an isolation layer and only papular lesions on erythematous base demonstrated increased temperature. Because of those effects, the authors examined only joints, over which no psoriatic lesions have been observed, demonstrating increased temperature [97].

Our preliminary study demonstrated fairly increased skin temperature on thermography over the lesions which were in an active phase and over the clinically uninvolved skin, which later transferred into psoriatic lesions [100]. Further study comprised patients with a long medical history of psoriasis vulgaris in which previously psoriatic arthritis was excluded. Active lesions demonstrated increased temperature over the clinically visible plaques and their surroundings whereas stable lesions showed increased temperature virtually only over the plaques themselves [101].

Discussion

Thermographic imaging is increasingly used in medical diagnosis, evaluation of disease severity and treatment planning, especially associated in conditions characterized by an increased blood flow or inflammation development [102, 103,104].

This method is used in the evaluation of chilblains, burns, ulcers of various origins and healing processes. It is also employed in monitoring of anti-inflammatory treatment, cryotherapy, and chemotherapy. Evaluation of necrotic tissue by thermography is based on distorted blood flow in microcirculation of the skin and subcutaneous tissue which results from the process of burn injuries [1,5].

Despite, quite an extensive literature data on the different dermatological applications of thermography, one has to bear in mind that proper standardization protocols are absolutely prerequisite for this technique to become a reliable screening method in dermatological practice [105,106]. It should also be stressed that only controlled, well-designed, studies, preferably with large groups of carefully selected and allocated patients are the prerequisite for thermography to become a good diagnostic tool in medical, and including dermatological, practice.

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Thermographic
examination for diagnosis of abdominal pain in children

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SUMMARY

Abdominal pain of children, is despite medical progress, still a difficult and complicated diagnostic problem. The type of pain, its localization and associated symptoms do not always lead to easy diagnostic decisions and demand the use of additional laboratory tests and diagnostic imaging. The aim of this study was to investigate the usefulness of thermographic examination (THV) as a screening method for the identification of the underlying course of abdominal pain in children.

Material and Methods. **A prospective study was conducted in 46 children, aged 2 – 18 years, who were hospitalized at the Departments of Pediatrics of Silesian Medical University in Katowice, between from 2002 to 2003. All patients suffered from abdominal pain, usually chronic and with various localizations. A control group of 20 healthy children in the same age was also studied. The Flir System THERMACAM PM595 was used for thermal imaging, which was performed under standard thermal conditions. Prior to the readings of the thermal images, the investigator was blinded for clinical symptoms and pain localization.**

Results. **Only 4 of 46 children had normal thermal images (8,7%). Abnormal thermal images were found in the 42 children. Thermal abnormalities did not always correspond with abdominal pain and/or the localization of the affected organ. Hot spots were observed on the left hand side of the lower abdomen and/or a "patchy" image of the entire abdomen in children with functional disturbances of the alimentary tract or colitis. Warm areas corresponding with the anatomical localization were seen in children with liver and pancreas diseases. Hot spots on thermal images outside the abdominal region in 3 children, lead to the correct diagnosis (neoplasm in two patients, sinusitis in one).**

Conclusions. **The thermographic examination can be a useful screening method for the detection of the underlying cause in children suffering from of abdominal pain.**

Key words: **abdominal pain, children, thermal imaging, pain causes**

THERMOGRAPIE ZUR DIAGNOSE VON BAUCHSCHMERZEN BEI KINDERN

Kindliche Bauchschmerzen sind trotz des medizinischen Fortschrittes noch immer ein schwieriges und kompliziertes diagnostisches Problem. Die Schmerzart, die Schmerzlokalisation und die Begleitsymptome erlauben nicht immer eine einfache Diagnosenstellung und erfordern weiter Labor - und bildgebende Untersuchungen. Ziel der Studie war es, den Beitrag der Thermographie zur Ursachensuche von kindlichen Bauchschmerzen zu bestimmen.

Material und Methoden: **46 Kinder im Alter zwischen 2 – 18 Jahren, die an den Kinderabteilungen der Schlesischen Medizinuniversität in Katowice zwischen 2002 und 2003 wegen Bauchschmerzen hospitalisiert worden waren, wurden prospektiv untersucht Alle Kinder litten unter Bauchschmerzen, meist von chronischen Verlauf und mit unterschiedlicher Lokalisation. Eine Kontrollgruppe von 20 Kindern gleichen Alters wurde ebenfalls untersucht. Das Flir System THERMACAM PM595 wurde für die Erfassung der Wärmebilder verwendet, die unter standardisierten thermischen Bedingungen aufgenommen wurden. Vor der Auswertung der Thermogramme wurde der interpretierende Untersucher hinsichtlich der klinischen Symptome und der Schmerzlokalisation verblendet.**

*Ergebnisse.***Nur 4 der 46 Kinder boten unauffällig Wärmebilder (8,7%). Abnormale Thermogramme wurde bei 42 Kindern erhoben. Die thermischen Auffälligkeiten korrespondierten nicht immer mit Bauchschmerzen und/ oder dem erkrankten Organ. Bei Kindern mit funktionellen Darmerkrankungen oder mit Colitis wurden warme Zonen an der linken Seite des Unterbauchs oder eine fleckiges Muster am gesamten Abdomen gesehen. Warme Zonen stimmten mit den Projektionszonen der erkrankten Organe bei Kindern mit Erkrankungen der Leber oder des Pankreas überein. Auf Grund der thermographischen Untersuchung wurde bei 3 Kindern die zutreffende Diagnose (Neoplasmen bei 2 Patienten, Sinusitis bei einem) gefunden, wobei in den Thermogrammen die warmen Zonen außerhalb der Abdominalregion zu sehen waren.**

Schlussfolgerung: **Die Thermographie kann als wertvolle Suchmethode für die Entdeckung der Schmerzursache bei kindlichen Bauchschmerzen bezeichnet werden.**

Schlüsselwörter: **Bauchschmerzen, Kinder, Thermographie, Schmerzursache**

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IIntroduction

Finding a diagnosis is the most difficult part of clinical medicine. Abdominal pain is a common problem in childhood. It accounts for up to 5% of paediatric clinic visits. Recurrent abdominal pain in childhood is still a symptom that is both difficult to understand and to identify its cause. The prevalence of organic disease responsible for the pain has ranged from less than 10% to more than 50%.(1, 2, 3)

Abdominalgia, pain in the abdomen, is a multi-dimensional experience - sensible, emotional and cognitive. Neuro-physiological processes inside of the spinal cord transfer and already modify the pain information. cortical analysis centres are involved in an increased or decreased sensation of pain. Visceral hyperalgesia means increased sensation of the pain. Changes in synapses of the sensory neurons and interneurons of the spinal cord refer the pain in fields of a skin and abdominal wall by using the same inter-neurons.This phenomena was called viscero – somatic convergency.(4, 5)

Abdominal pain in children may be caused by inner organs, metabolic and functional reasons from the digestive tract and from organs behind the digestive tract.(6, 7)

The aim of this study was to investigate the usefulness of the thermographic examination (THV) as a screening method for the underlying cause of abdominal pain in children.

Material and Methods

A prospective study was conducted inf 46 children, aged 2 – 18 years, who were hospitalized at the Departments of Pediatrics of Silesian Medical University in Katowice, between 2002 and 2003. All patients suffered from adominal pain, usually chronic and with various localizations..

The investigation covered a detailed medical history, a physical examination, blood, urine and stool samples, immunological examinations for malnutrition syndrome. The somatic investigation was completed by abdominal X-ray or TC or ultrasound examinations, PH-value monitoring in the lower esophagus, upper gastrointestinal endoscopy, and psychological tests. Clinical symptoms and pain localization was blinded for thermographist. Children report often the localization of pain in one or more than one anatomical regions to the physician. The reported localization of pain and the inner organ affected were compared and with the findings of the thermographic examination after all necessary diagnostic procedures have been performed..

A control group consisted of 20 healthy children in the same age.

The Flir System THERMACAM PM595 was used for thermal imaging, which was performed under standard thermal conditions.

The thermographic evaluation was qualitative. We examined the appearance of hot and cold spots over the entire wall of the abdomen, the lumbar area and in some cases in other regions of the body.

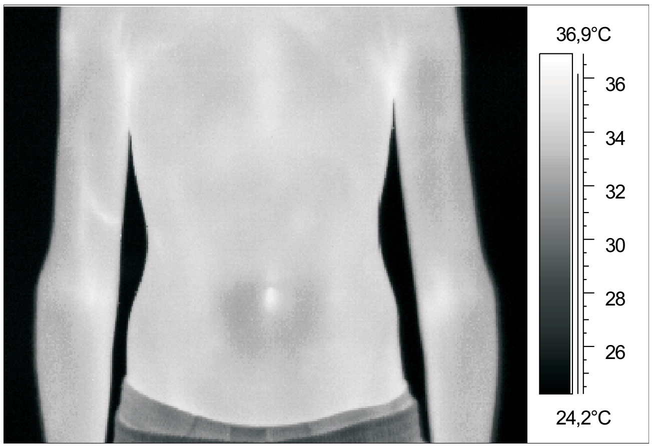

Figure 1.
9 year old healthy boy. The thermal image is symmetrical, without any cold and hot spots. The umbilicus is hot.

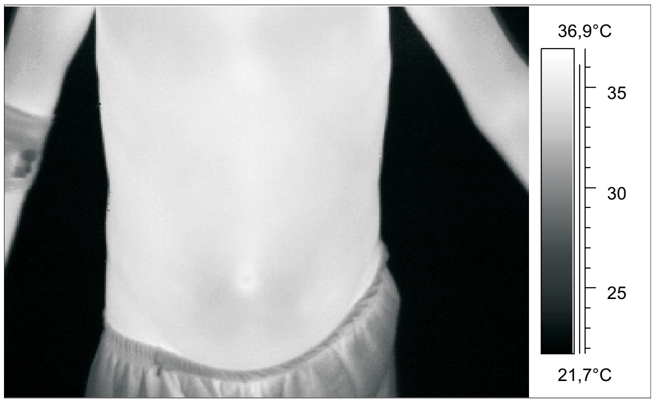

Figure 2.
Pancreatitis. 9 year old girl;, warm region over the pancreas

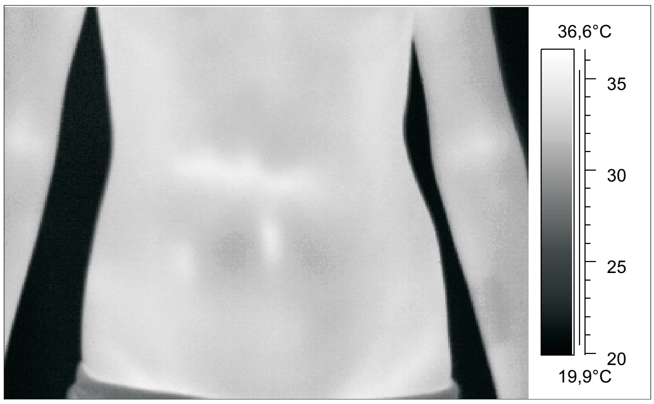

Figure 3.
Pancreatitis. 10 year old girl;. warm region over the pancreas

Table 1: Pankreas disease

No.	initials/age	gender	localization			Coincidence of THV with		diagnosis
			pain	THV	affected organ	pain	affected organ	
1	KS 9	female	epigastrial	epigastrial	pancreas	+	+	pancreatitis
2	KS 9	female		normal		+	+	healthy after pancreatitis
3	MK 4	female	peri-umbilically	peri-umbilically and epigastrial	pancreas	+	+	pancreatitis
4	PM 10	female	peri-umbilically	peri-umbilically	pancreas	+	+	pancreatitis

Calculation of diagnostic value.

The coincidence of temperature changes with pain location and with the affected organ was determined. From the percentages of true positives, true negatives, false positives and false negatives, sensitivity and specificity of thermal imaging for pain location and affected organ were calculated.

Results

In the control group the thermographic image of the abdominal wall of and the lumbar region was symmetrical without any hot and cold spots. Only the hot navel (fig 1) and warmer region of the vertebral column were observed.

In patients with pancreatitis the warmer areas was observed over the projection of the organ on the surface of the body.(fig 2, 3).

The highest (100%) percentage of the correct diagnosis of the thermographic examination was obtained in diseases of the pancreas.both with relation to the location of the pain and the affected organ. These results are due to the characteristic localization of the pain in at this organ and is highly biased by the small number of cases in this group of disordes (Table 1)

In patients with gastroenterocolitis a patchy pattern of the entire abdomen was seen (fig 4, 5).

In children with colitis ulcerosa warmer areas in the left lower abdomen were observed (fig 6).

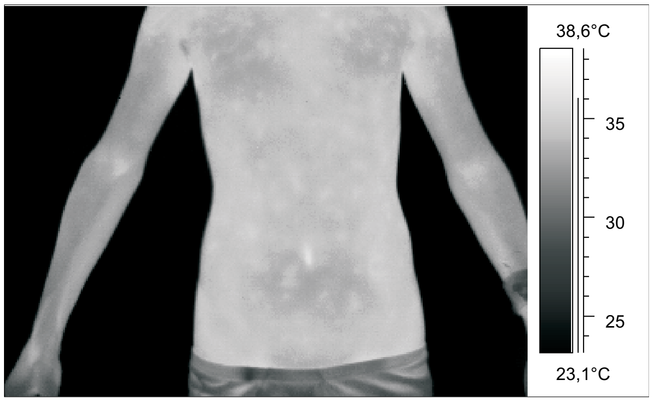

Figure 4.
Gastroenterocolitis. 1 year old girl: patchy image of the entire abdomen

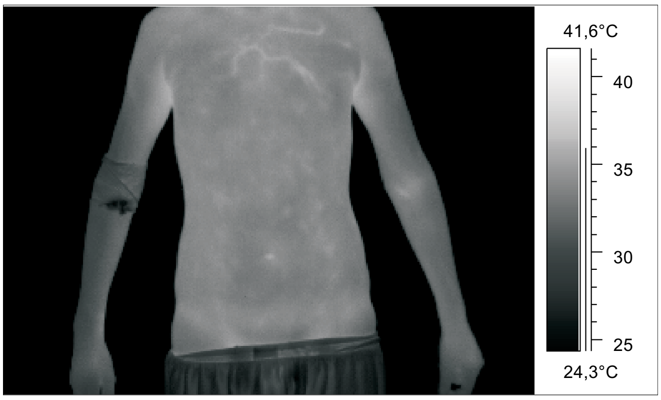

Figure 5.
Gastroenterocollitis. 6 year old boy; patchy image of the entire abdomen

Table 2
Liver diseases

No.	initials/age	gender	localization			Coincidence of THV with		diagnosis
			pain	THV	affected organ	pain	affected organ	
1	ST 3	male	right site from umbilicus	right site from umbilicus	liver	+	+	Cystis hepatis
2	NA 7	male	right site from-umbilicus	right site from umbilicus	liver	+	+	Cystis hepatis
3	WM 11	female	right site from-umbilicus	right site from umbilicus	liver	+	+	Hepatitis B
4	KJ 14	male	Ø	right epigastrial	liver	-	+	Antigenaemia HBs
5	MN 5	female	Ø	epigastrial	liver	-	+	Glycogenosis
6	BA 9	female	Ø	right epigastrial	liver, intestine	-	+	Yersiniosis; Diarrhoea rec

Ø no pain during THV examination
Sensitivity THV/pain 50 %
Percentage of correct diagnosis THV/pain 50%
Sensitivity THV/affected organ 100 %
Percentage of correct diagnosis THV/affected organ 100%

Figure 6.
Collitis ulcerosa.13 year old girl.; warm area in the lower abdomen

Figure 7.
Hepatis B. 7 year old boy; hot area in the liver region

Table 3.
Diseases of the upper digestive tract

No.	initials/age	gender	localization			Coincidence of THV with		diagnosis
			pain	THV	affected organ	pain	affected organ	
1	CJ 13	female	Peri-umbilically& lower abdomen	left lower abdomen	intestine	+	+	Colitis ulcerosa
2	HM 14	male	peri-umbilically & left lower abdomen	left lower abdomen	intestine	+	+	Dolichocolon; Colitis indetermina
3	KM 14	male	peri-umbilically	right lower abdomen	intestine	-	+	Colitis indeterminata
4	KB 17	female	left lower abdomen	entire abdomen	stomach, intestine, adnexis	+	+	Gastritis; Colitis indeterminata; Adnexitis sin
5	KM 16	male	Peri-umbilically& lower abdomen	peri-umbilically	intestine	+	+	Colon irritabile
6	MA 15	female	peri-umbilically	peri-umbilically	intestine	+	+	Colitis indeterminata; St. post appendectomiam; Intolerantio lactosae
7	OM 3	female	during defecation	normal	intestine	+	+	Colitis indeterminata
8	S£ 18	male	peri-umbilically & left lower abdomen	epigastrial & left lower abdomen	intestine	-	+	Colitis indeterminata
9	SZ£ 12	male	right lower abdo-men	entire abdomen	intestine	+	+	Gastroenterocolitis acuta
10	WM 11	male	+ ?	peri-umbilically	intestine	+	+	Colitis indeterminata
11	ZS 5	male	peri-umbilically	right epigastrial & left lower abdomen	intestine	+	+	Colitis indeterminata ; Mb. Leœniowski – Crohn susp.
12	BA 11	female	+ ?	left lower abdomen	intestine	+	+	Obstipatio
13	BM 4		+ ?	left lower abdomen	intestine	+	+	Obstipatio

+? The perceived pain could not be localized by the child

Sensitivity THV/pain 83,3 %
Percentage of correct diagnosis THV/pain 92,3%

Sensitivity THV/affected organ 84,6 %
Percentage of correct diagnosis THV/affected organ 84,6%

Table 4
Diseases of the upper digestive tract

No.	initi-als/age	gender	localization			Coincidence of THV with		diagnosis
			pain	THV	affected organ	pain	affected or-gan	
1	BA 15	female	peri-umbilically & lower abdomen	peri-umbilically & lower abdomen	stomach	+	+	Gastritis
2	BJ 10	female	peri-umbilically	peri-umbilically & lower abdomen	stomach; intestine	+	+	Gastritis; Intolerantio lactosae
3	BK 6	male	Ø	epigastrial & peri-umbilically	stomach; intestine	+	+	Refluxus gastroesophagealis; Gastroenterocolitis acuta
4	DA15	female	epigastrial	epigastrial	stomach	-	+	Gastritis; Refluxus gastroeso-phagealis et gastroduodenalis
5	KR 13	male	epigastrial	epigastrial & peri-umbilically	stomach	+	+	Megalogastria
6	KS 11	male	epigastrial	epigastrial	stomach; intestine	+	+	Intolerantio lactosae
7	CA 11	female	peri-umbilically	entire abdomen	stomach; intestine	+	+	Gastroenterocolitis acuta
8	OR 14	male	right lower abdomen	normal	stomach; intestine	+	-	Gastritis; Intolerantio lactosae
9	BE 5	female	peri-umbilically	peri-umbilically	duodenum; intestine	-	+	Intolerantio lactosae; Diarrhoea
10	CD 6	male	epigastrial & peri-umbilically	peri-umbilically & lower abdomen	stomach; intestine	+	+	Gastroenterocolitis acuta
11	PA 7	male	Ø	normal	stomach; duodenum	+	-	Gastritis et duodenitis; Infectio HP
12	SM 16	male	epigastrial	epigastrial & peri-umbilically	duodenum	+	+	Tumor duodeni; Intolerantio lactosae
13	ZA 4	female	peri-umbilically	peri-umbilically	stomach; duodenum	+	+	Gastritis et duodenitis

Ø no pain during THV examination

Sensitivity THV/pain 83,3 %
Percentage of correct diagnosis tHV/pain 92,3

Sensitivity THV/affected organ 84,6 %
Percentage of correct diagnosis THV/affected organ 84,6

In some patients with pyelonephritis little hot spots at lumbar area were found.

Very hot spots (δT>1,5°C) were found in children with neoplasms or with hepatitis B.(fig 7)

The results of the thermographic examinations in various diseases is summarized in the tables 1 – 5 .

In the liver diseases both the sensitivity and the percentage of thermal images for the correct diagnosis and the localisation of the origin of the pain were low and did not cross 50 %. However, sensitivity and percentage of true thermographic findings for the identification of the affected organ was 100% (Table 2). This results from the painless course of some diseases such as antigenaemia HbS, glycogenosis or yersiniosis.

In disorders of the upper and lower digestive tract, better correlations were obtained between the thermographic examination and the affected organ than with the localization of the pain. (Table 3, 4).

In the group of other diseases, the sensitivity and percentage of thermal imaging for correct diagnosis causing the pain, was only 20%, but the affected organ was identified in ll 90% (Table 5).

The analysis of the results suggested, that children have tendencies to the localize pain at the abdomen, despite that the causing illness is related to organs outside of the abdomen.

For example, patient JK (Table 5) was diagnosed partly based on the thermographic examination, to suffer from sinusitis, an affected organ that is anatomically distant from the location of the pain. In the patients SW and WW (Table 5) the affected organ was found in the retroperitoneal space.

In our study the changes of the temperature in the thermatomes correlated rather with the affected organ than with the pain localization.. The sensitivity of the thermographic examination for the localization of the organ in the total group of patients was , and percentage of correct diagnoses was 91,3 The sensitivity of the thermographic examination for localization of the pain was considerably lower with 65,9%, and the percentage of the correct diagnosis was 67,6%

Discussion

In order to avoid bias in the thermographic examination, the reader of the thermal images was blinded for the clinical data of the patient. It seems however, that in everyday clinical practice this knowledge together with the physical investigation of the patient is necessary for making diagnostic decisions. Therefore in unclear cases, a thermographic examination should also be performed in anatomical regions distant from the given complaints.

Pain is defined as "an unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in terms of such damage". A complex series of physiologic processes, collectively termed nociception, starts at the site of active tissue damage and ends with the perception of pain. The mechanisms that underlie the development of acute or persistant pain are related to neuro. chemistry (bradykinin, prostaglandins, leukotrienes, substance P, acethylcholine, histamine, hydrogen ion, and potassium,8).

Perception of the pain depends on emotional and physical experience of pain. Painful experiences may influence the nervous system to develop hyperalgesia.(4, 9)

If the sensation of pain is a chemical and neurogenic process, can the pain be visible in infrared images ? (10, 11, 12,13) If pain is of peripheral and central origin, what is psychogenic pain? Alfven reported in in a recent publication organ related reasons of pain in only 25% of all cases.

Table 5
Other diseases

No.	initials/age	gender	localization			Coincidence of THV with		diagnosis
			pain	THV	affected organ	pain	affected organ	
1	BM 8	female	lower abdomen; lumbo-sacral area	lumbo-sacral area	lumbar spine	+	+	Angioma reg. vert. L3
2	BN 8	female	lower abdomen	lumbar area	kidney	+	+	nfectio tractus urinarii; Refluxus vesico – ureteralis
3	DM 8	male	+?	normal	kidney	-	-	Glomerulonephritis
4	GJ 3	female	peri-umbilically lower abdomen	lumbar area	kidney	+	+	Pyelonephritis et cystitis
5	JK 10	male	+?	peri-nasal sinuses	peri-nasal sinuses	-	+	Sinusitis
6	KW 6	female	peri-umbilically	lumbar area	kidney	-	+	Pyelonephritis
7	SW 2	female	entire abdomen	thoraco-lumbar area	spine	-	+	Neuroblastoma
8	S.A. 16	male	Ø	lumbar area	kidney	-	+	Infectio tractus urinarii;
9	TA 9	female	Ø	lower abdomen; lumbar area	bladder; kidney	-	+	Pyelonephritis acuta et cystitis
10	WW 2	female	+?	peri-umbilically; lumbar area	retroperineal area	+	+	Cystis spatio retroperitonealis;

Ø no pain during THV examination
Sensitivity THV/pain 20%
Percentage of correct diagnosis THV/pain 20%

+? The perceived pain could not be localized by the child
Sensitivity THV/affected organ 90%
Percentage of correct diagnosis THV/affected organ 90%

Nearly half of the patients was diagnosed as psychogenic pain.(14)

The thermographic examination supported diagnosis in several patients in which the localization of the pain differed from the diseased organ. Abnormal thermograms of patients in which an organic cause of symptoms could not be found, lead to the diagnosis of psychosomatic, e.g. colitis, obstipation, but not psychogenic diseases

Conclusions

Based on of the results of this study, the following conclusions were made:

The thermographic examination may be a useful screening method for the detection of the underlying cause in children.suffering from of abdominal pain.

Thermography helps to localize the affected organ.

The thermographic examination supports the identification of psychogenic pain.

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Hypothenar Hammer Syndrome: Case Report with Clinical and Infrared Thermographic Correlations

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SUMMARY

A 65 year old male veterinary clinician presented with a 2 month history of localized tenderness in the right wrist. The wrist pain was limiting the patient's active range of motion in wrist flexion. Pre-surgical arteriographic examination revealed an ulnar arterial aneurysm with thrombus in the right hypothenar region. Pre-operative thermographic imaging of the ulnar wrist and hand (palmar surface) demonstrated a surface temperature asymmetry of 0.55ºC (right symptomatic wrist and hand colder). The patient subsequently underwent surgical excision of a 1.75 cm thrombus and anastomotic reconstruction of the ulnar artery. Ten days post surgery, the infrared imaging confirmed a slightly warmer (0.02°C) right hand and wrist which corresponded to the inflammatory post surgical swelling in the region. By three weeks the right hand and wrist was 0.02°C cooler with some persistent edema still present around the sutures. At six weeks the right hand was 0.05°C cooler, no observable edema, and the patient had regained full active range of motion and returned to full occupational and recreational activities. He remains asymptomatic two years post operatively. This case study demonstrated the utility of thermography as a valid, non-invasive method for assisting in the diagnosis of hypothenar hammer syndrome and providing an assessment of the normalization of circulatory function post-operative.

Key words: Hypothenar hammer Syndrome, thermography, surgical treatment

KORRELATIONEN VON KLINISCHEN UND THERMOGRAPHISCHEN BEFUNDEN BEIM HYPOTHENAR HAMMER SYNDROM: EIN FALLBERICHT

Ein 65 Jahre alter Veterinär wurde wegen seit 2 Monten bestehender lokaler Druckempfindlichkeit des rechten Handgelenks vorgestellt. Der Handgelenkschmerz beeinträchtigte den aktiven Beugungsumfang des Patienten. Eine präoperative Arteriographie zeigte ein thrombosiertes Aneurysma der A. ulnaris im Bereich des Hypothenars. Eine thermographische Untersuchung des ulnaren Handgelenks und der Handfläche fand vor der Operation eine asymmetrische Temperaturverteilung (die symptomatische rechte Hand war um 0.55°C kälter). Anschließend wurde beim Patienten ein 1.75 cm langer Thrombus chirurgisch entfernt und eine Rekonstruktion der A. ulnaris vorgenommen. In der thermographischen Untersuchung 10 Tage nach der Operation zeigte sich die rechte Hand in Übereinstimmung mit der postoperativen Schwellung im Bereich des Handgelenks gering gradig wärmer (0.02°C). 3 Wochen postoperativ fand sich the rechte Handfläche und das Handgelenk um 0.02°C kühler und bot noch eine ödematöse Schwellung im Bereich der Operationsnarbe. Sechs Wochen nach der Operation erschien die rechte Hand um 0.05°C kühler und zeigte keine ödematöse Schwellung mehr. Der Patient hatte wieder einen normalen Bewegungsumfang im Handgelenk erreicht und die normalen beruflichen und Freizeitaktivitäten aufgenommen. 2 Jahre nach der Operation ist er noch immer beschwerdefrei. Dieser Fallbericht zeigt die Brauchbarkeit der Thermographie als valide, nicht invasive Methode zur zusätzlichen Stützung der Diagnose eines Hypothenar Hammer Syndroms, die auch eine postoperative Beurteilung der Wiederherstellung einer normalen Zirkulation gestattet..

Schlüsselwörter: Hypothenar Hammer Syndrom, Thermographie, chirurgische Behandlung

Thermology international 2005; 15: 63-67

Introduction

Hypothenar hammer syndrome (HHS) is characterized by ulnar artery occlusion following recurrent blunt trauma to the palm of the hand. Presenting symptoms can include pain, increased cold sensitivity, intermittent numbness and/or tingling to any digits except for the thumb in the involved hand [1]. Objective signs of arterial or neural involvement are variable. Adequate collateral blood supply to the hand and the absence of thrombus, aneurysm or embolus permits non-operative treatment as an initial intervention. Damage to the arterial intima can lead to development of arterial thrombi, while damage to the tunica medica can result in arterial aneurysm. Progression from thrombus to embolus can occlude vascular flow to the digits [2]. In addition, scarring of vascular tissue secondary to repeated trauma can result in arterial occlusion [3]. Although arterial aneurysm and thrombus can occur as separate conditions, Vayssairat and colleagues have reported the development of arterial thrombi subsequent to aneurysm in three patients [4]. Under these conditions, HHS treatment often requires surgical resection of the involved arterial segment and subsequent reestablishment of blood flow.

The development of arterial aneurysm following repetitive trauma to the ulnar artery was first described in a Roman coachman in 1772 by Guattani [5]. In 1934, Von Rosen was the first to describe the development of an ulnar thrombus secondary to repeated trauma. Conn introduced the term "hypothenar hammer syndrome" in 1970 to describe the condition [1]. Other terns for HHS have included "post-traumatic digital ischemia", pneumatic tool disease", and "hammer hand syndrome" [6,7].

Individuals at risk for HHS development include manual laborers and athletes [10, 11] who sustain repetitive trauma to the palm of the hand during striking, catching, gripping activities [3]. Repeated long term use of hammers, screwdrivers or pneumatic tools can also incite this condition [8,9]. As a result, HHS has been traditionally been diagnosed in the dominant (or catching) hands of males [12]. However, there have been case reports of HHS in a female sculptor due to repetitive hammering of stone [4]. In addition, O'Conner and colleagues have described the development of HHS in the non dominant hand due to repetitive applauding [13].

The majority of studies suggest that HHS results from recurrent micro-trauma. However, Jagenburg and associates have reported that this condition can result from a single traumatic episode [14]. Similarly, Kleinert and Porubsky have each reported the development of HHS secondary to a single episode of blunt non-penetrating macro-trauma to the hypothenar region [15, 16].

Anatomical Considerations

The ulnar artery serves as the primary blood supply to the hand [9]. The artery courses distally through the upper extremity until it divides into superficial and deep branches with Guyon's Canal [9, 16]. The superficial branch (along with a supporting superficial branch of the radial artery) subsequently forms the superficial palmar arch, while the deep ulnar branch joins the radial artery to form the deep arterial arch [9, 17]. As a result, good vascular collateralisation exists within the hand [3].

There is disagreement within the literature concerning the course of the ulnar artery once it enters the hand. Linsey et al. found no deep branch of the ulnar artery in 31 adult cadavers. They have suggested that others may have mistaken hypothenar arterial branches for a deep branch of the ulnar artery [17].

The common volar digital arteries course from the superficial palmar arch to serve as the primary vascular supply to the digits of the hand. Porubsky and colleagues [16] have suggested that ischemia can develop in any finger following occlusion of the ulnar artery or superficial palmar arch. However, Conn, Bergin et al [1] noted that HHS related symptoms do not involve the thumb. Case reports suggest that ischemia generally involves combinations of the middle, ring, and small fingers, although the index finger can also be affected [4, 7, 19].

Within Guyon's Canal, the ulnar artery and nerve are bounded superficially by the volar carpal ligament, dorsally by the transverse carpal ligament, and laterally by the pisiform and hamate bones [2].. The artery is securely positioned between the carpal ligaments and lies upon the hook of the hamate within the Canal [3] Upon exiting the Canal, the artery's superficial branch courses for one to two centimeters before continuing deep to the palmar aponeurosis [3; 20]. The superficial branch then terminates deep to the aponeurosis in the superficial palmar arch [2].

The superficial branch is protected only by cutaneous and fatty tissue as well as palmaris brevis muscle fibers in the region between Guyon's Canal and the palmar aponeurosis. As a result, it is particularly susceptible to blunt trauma within this one or two centimeters segment. Repetitive microtrauma (or single episodes of macrotrauma) in this region can compress or "hammer" the artery proximally against the hook of the hamate . [2, 3]. Vasospasm and damage to either the intima or the tunica media or the artery can result [3].

Potential Predisposing Factors

Ferris and colleagues [19].have proposed that an underlying predisposition to HHS exists in certain individuals. They noted that palmar ulnar artery fibromuscular dysplasia (FMD), marked by elongation and a "corkscrew" appearance of a patent artery, was evident bilaterally in 12 of 13 HHS patients. As a result, they have suggested that preexisting FMD places an individual at increased risk for development of HHS

In case reports of two patients with HHS, Hammond [21] and Mueller [22] each noted a corkscrew or tortuous appearance of the distal ulnar artery in the symptomatic hand. Unlike Ferris however, Hammond and Mueller both suggested that the corkscrew appearance resulted from repeated trauma to the vessel .

The degree of collateral circulation in the hand will affect one's risk for developing symptomatic HHS. Little and associates have suggested that collateral circulation in the hand will usually prevent ischemic changes in the fingers despite ulnar or radial artery occlusion . Nevertheless, variations in collateral circulation to the hand exist. Individuals with diminished collateral circulation are at greater risk for symptomatic HHS .

Diagnostic testing

Brachial arteriography is the predominant measure associated with the diagnosis of HHS. It enables the clinician to identify arterial blockage sites, assess collateral circulation, distinguish between vasospastic activity and the presence of either thrombus or aneurysm, and identify potential emboli [3]. There is a concern among some clinicians that the arteriographic procedure could actually incite vasospasm in certain patients .

Allen's Test is a manual test that evaluates ulnar and radial artery circulation via capillary refill [3, 23]. Cold stress testing can reveal a characteristic cooling and rewarming pattern in affected fingers. Doppler mapping can be beneficial in assessing vascular flow and identifying thrombi [3]. The three phase bone scan provides a dynamic visualization of vascular flow [3]. Digital plethysmography enables the clinician to assess pulsatile flow in the fingers .

Infrared thermography provides a non-invasive, non-contact, dynamic assessment of surface skin temperatures of both hands . The infrared camera detects the heat emitted from the body within the infrared spectrum and presents no risk to the patient or imaging technician. This topical map of the skin surface temperature can provide accurate thermal measures of a specific site or the high, low, mean skin temperatures of a region determined by the clinician. This can provide valuable diagnostic information regarding the extent of the patient's clinical malady or can help document progress during recovery or rehabilitation. In some clinical cases, further information can be derived by challenge testing (warm or cold water immersion, convective air movement, or exercise) in which the dynamic response of the skin is determined. In this clinical case, the subject's extreme sensitivity to thermal perturbations made stress testing impractical.

Neural involvement may result from compression of the sensory branch of the ulnar nerve or a digital nerve . Ischemic neuritis may also result . Tinel's testing and assessments of light touch sensation and two point discrimination may be indicated as based upon the patient's sym -ptoms .

Treatment Considerations

Non-surgical intervention may be appropriate in the presence of sufficient collateral circulation to the hand. In addition, non-surgical treatment may be effective in cases of HHS secondary to vasospasm (in the absence of thrombus, aneurysm, or emboli). Activity modification, tobacco cessation, cold avoidance, and stress management (when indicated) are interventions that the patient can institute. Pharmacological interventions include the use of vasodilators, anticoagulants, corticosteroids or calcium channel blockers [3]. Sympathectomy or stellate ganglion blocks may also be indicated [3].

Surgical intervention is indicated in the presence of inadequate collateral circulation, presence of thrombus, aneurysm, or emboli, or failure of non-surgical interventions. Arterial resection and ligation per the principle of Leriche was common through the mid-1960's . Subsequently, surgical techniques have focused upon reestablishment of arterial flow via end to end anastomosis or microsurgical reconstruction of the artery . Koman has noted that HHS residual symptoms are common regardless of the intervention protocol (24) .

Case Study

A 65 year old right hand dominant, non-smoking male veterinarian presented with a 2 month history, insidious onset, of localized tenderness in the right wrist. He had specialized in large animal care for 30 years. The patient reported that he tightly wrapped a rope around his right wrist on a regular basis when stabilizing the head of a horse during the induction of anaesthesia.

During the objective examination, the patient demonstrated an inability to fully flex the right wrist due to pain. Sensory (Tinel's test , light touch sensation, two point discrimination) and vascular testing were unremarkable. Radiographic imaging was unremarkable. MRI imaging revealed abnormal signal intensity in the area of the ulnar artery within the region of mass. Arteriographic imaging revealed possible ulnar thrombotic syndrome with no filling of the common digital arteries of either the ring finger or small fingers. Arteriographic imaging also revealed an area of incomplete filling with tapering of the ulnar artery at the area of the mass. Based on these findings, the patient was scheduled to undergo surgical resection of the thrombus and end to end anastomosis of the artery.

The patient subsequently underwent surgical excision of a 1.75 cm thrombosed arterial segment and end to end anastomosis of the ulnar artery (see Images 1 & 2). He did not undergo post-operative rehabilitation, but gradually increased his daily activities as tolerated.

Prior to surgery, the patient underwent infrared (IR) thermographic imaging to compare mean surface temperatures of his wrists and hands bilaterally. Testing was conducted with the Bales™ Thermal Image Processor 50 system (Computerized Thermal Imaging, Inc, Lake Oswego, OR 97035). Testing was conducted following fifteen minutes of equilibration. During this time, the patient sat quietly while holding his forearms, wrists and hands away from his body. In addition, the patient refrained from eat-

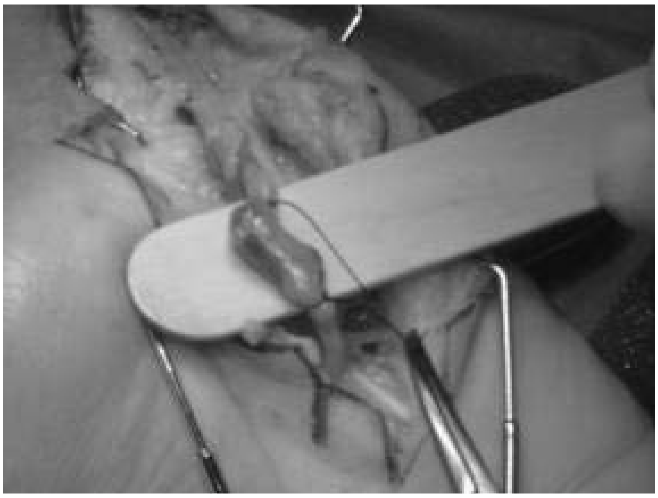

Image 1
Thrombosed segment of the ulnar artery

Image 2
End to end anastomosis of the ulnar artery

Image 3:
Pre-Surgical Thermographic Imaging: Asymmetry-
Right hand colder (0.55°C)

Image 4:
Post-Surgical Thermographic Imaging: symmetry
Right hand colder (0.05°C).
System Settings: Sensitivity: 0.05°C; Range: 30.45-35.95°C;

ing, drinking, and performing strenuous activity during the hour prior to testing. Thermographic testing throughout the period of this case study was conducted at the same time of day to minimize the influence of circadian rhythms on surface temperatures.

Preoperative thermographic imaging of the ulnar wrist and hand (palmar surface) demonstrated a surface temperature asymmetry of 0.55°C (symptomatic extremity colder: Image 3) A side to side mean temperature difference of 1°C or greater is generally considered to be clinically significant regardless of body region [25]. However, Uematsu has suggested that an asymmetry of 0.24±0.23°C at the palmar surface of the hand may be clinically significant [25]..

IR imaging conducted ten days post-operatively revealed a surface temperature asymmetry of 0.02°C (affected extremity warmer). Edema was evident in the region of the surgical sutures. By three weeks post-operatively, the patient's symptoms had resolved. Mean surface temperature asymmetry at the ulnar wrist and hand was 0.02°C (affected extremity cooler). Mild residual edema was present along the incision site. By six weeks post-operatively, the patient had regained full active range of motion. Mean surface temperature asymmetry was 0.05°C (affected extremity cooler- Image 4). The patient returned to full occupational and recreational activities within six months after surgery. He remains asymptomatic two years postoperatively.

Although digital IR thermography cannot be used alone to diagnose medical conditions, it can assist in the diagnosis of various conditions. In turn, serial thermographic testing can demonstrate surface temperature changes resulting from the progression of untreated conditions or the return to baseline temperatures following medical intervention. This study demonstrates the utility of thermography as a valid, non-invasive method for assisting in the diagnosis of HHS and providing a visual display of the normalization of circulatory function postoperatively.

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A 16-year old male with low back pain and an inflamed left ankle joint- a case report

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SUMMARY

16-year old male patient was admitted to the Pediatric and Nephrology Department of the Military Institute of Health Service in Warsaw due to pain of alternating intensity in his left talo-crural joint that has been present for 5 months. For over 2 years the patient has been under orthopaedic and neurological care in another health centre due to low-back pain, that appeared after a minor trauma. In the first twenty-four hours of patient's stay in the hospital, thermography of both lower extremities was performed that revealed difference in mean temperature of the areas over the left and right ankle joints. Thermal imaging, patient's history, ultrasound and X-ray examination results led us to a diagnosis of chronic inflammation of the left Achilles tendon attachment to the calcaneal bone.

Key Words: Thermal imaging, inflammation, Achilles tendon attachment

EIN 16 JÄHRIGER MIT KREUZSCHMERZEN UND EINER LINKSSEITIGEN SPRUNGELENKSENTZÜNDUNG - EIN FALLBERICHT

16-jähriger Patient wurde wegen Schmerzen im linken Sprunggelenk, die in unterschiedlicher Intensität seit 5 Monaten bestanden, an der Pädriatrischen und Nephrologischen Abteilung des militärischen Gesundheitszentrums in Warschau in stationäre Behandlung genommen. Der Patient war bereits seit zwei Jahren wegen Kreuzschmerzen, die nach einer kleinen Verletzung aufgetreten waren, in einem anderen Krankhaus in orthopädischer und neurologischer Betreuung. Innerhalb der ersten 24 Stunden des Aufenthaltes an unserer Abteilung wurde eine Thermographie beider unteren Extremitäten durchgeführt, die eine Differenz der mittleren Hauttemperatur über dem rechten und dem linken Sprunggelenk nachweisen konnte. Die Anamnese, die thermographische, Ultraschall- und Röntgenuntersuchung führten zur Diagnose einer chronischen Entzündung des Ansatzes der Achillessehne am Kalkaneus.

Key Words: Thermographie, Entzündung, Achillessehnenansatz

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Introduction

Spinal pain problems are frequent in the adult population. In paediatrics, the most commonly encountered causes of such pain are post-traumatic discopathies. Interarticular inflammatory pro- cesses in children can be either reactive arthritis or primary juvenile arthritis (1,2). In male adolescents peripheral manifestations of the onset of ankylosing spondylitis must also be considered especially when combined with back pain or sciatica (3).

Case study

16-year old male patient (M.T.), case history number 4831/ 2004, was admitted to the Pediatric and Nephrology Department of the Military Institute of Health Service in Warsaw due to pain of alternating intensity in his left talo-crural joint that has been present since September 2003. For over 2 years the patient had been under orthopaedic and neurological care in another health centre due to low-back pain, that appeared after a minor trauma (fall from the height of 2 meters). In September 2003, after one and a half years of conservative (medical) and rehabilitation therapy that had not improved the symptoms, a procedure of left-sided L5 - S 1nucleoplasty was performed.

The patient's inflammatory markers were elevated since the trauma episode – ESR – 52 – 96 mm/h, in recent months the pain of left ankle joint was accompanied by edema, reddening and increased temperature of this region. Non-Steroidal Anti-Inflammatory Drugs (NSAIDs) and various rehabilitation procedures were used in the patient therapy.

At admission no edema or reddening was noted in the area of either ankle joints. The patient reported only minor pain during passive and active movements in the affected joints. ESR was slightly elevated, 28 mm/h, WBC – 11 210/mm3, peripheral blood smear: bands – 4%, (segmented) neutrophils – 45%, lymphocytes: large – 6%, medium – 7%, small – 20%, immature – 1%, atypical – 4%; monocytes – 5% (the results indicating a chronic inflammatory state).

In the first twenty-four hours of the patient's inpatient stay, thermography of both lower extremities was performed (figure 1). There was a difference in mean temperature of the areas over the left and right ankle joints and forefeet.

The mean temperature of region above the left talo-crural articulation was 0.7°C higher. These results confirmed the need for further investigation for rheumatologic diseases, which proved to be negative. Borelliosis was also excluded.

X-ray examination of the left ankle joint (figure. 2) revealed loss of the left calcaneal tuberosity cortical layer in the area of the Achilles tendon attachment with the concomitant attach- ment displaced, most probably due to the inflammatory process. Ultrasound examination of this region

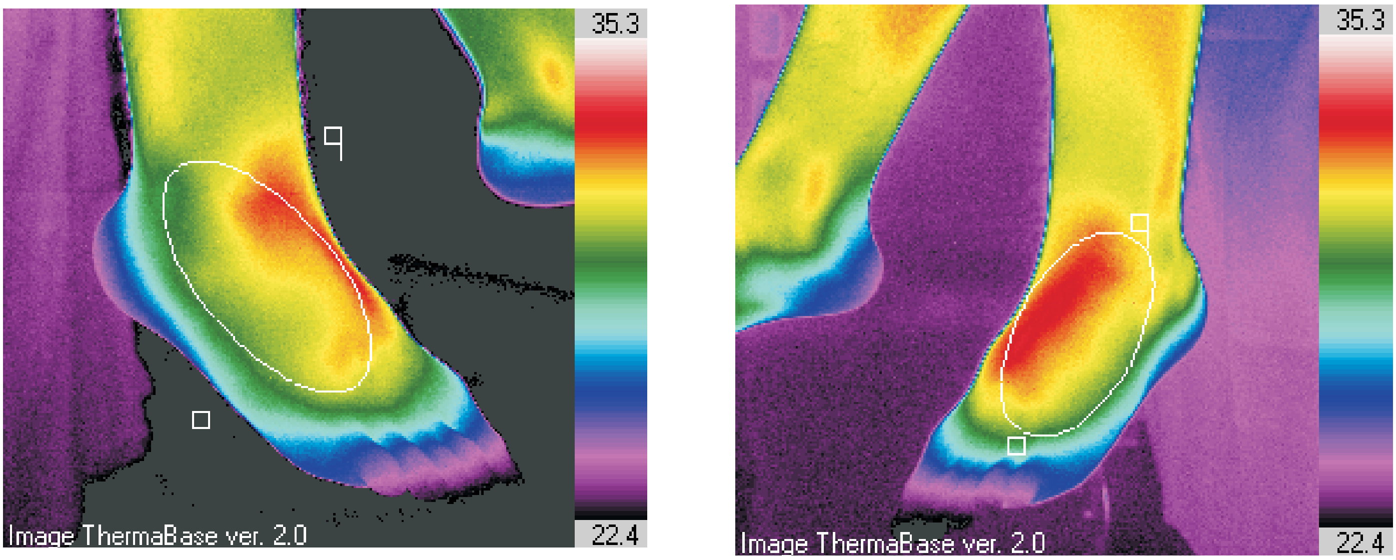

Figure 1
Thermograms of the skin above the talo-crural articulations - patient M.T
Right Foot - Tmean - 30,9oC, left Foot - Tmean - 31,6oC

Figure 2.
X-ray of the M.T. left talo-crural joint - visible cortical layer loss of the left calcaneal tuberosity in the area of the Achilles tendon attachment.

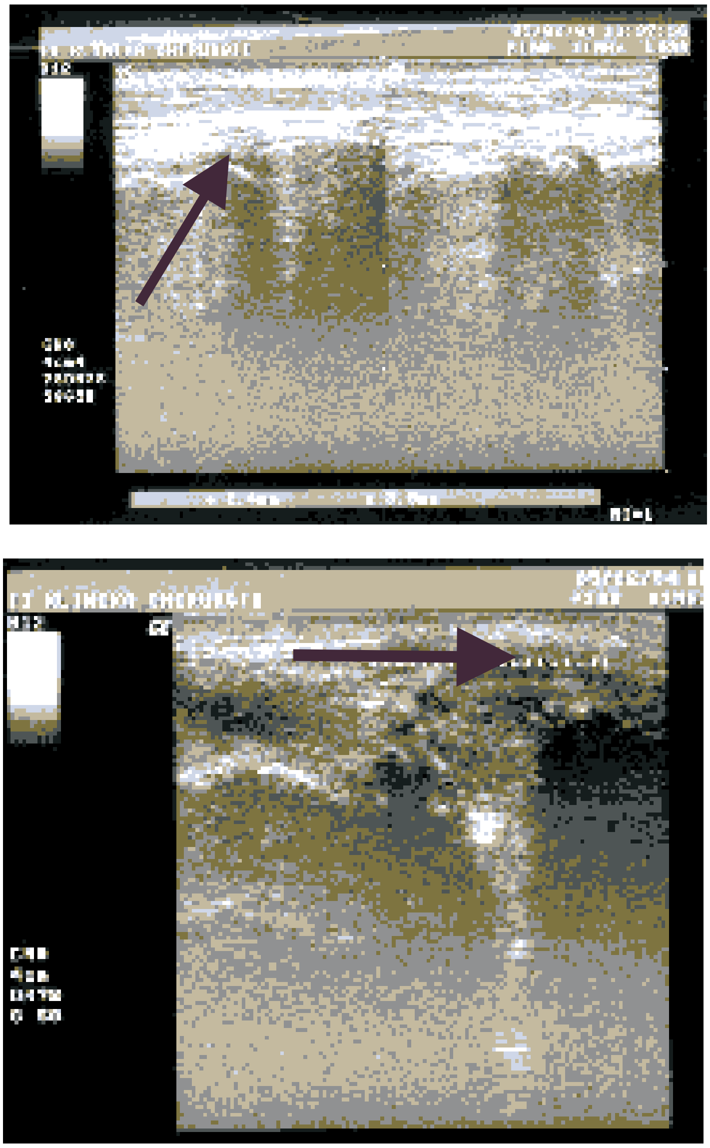

Figure 3
Left talo-crural joint ultrasound examination - fluid in the sheath of the tibialis anterior muscle, thickening of synovial membrane in the joint between the cuneiform and the metatarsal bones at the site of the tibialis anterior muscle tendon attachment.

(Figure. 3) revealed fluid in the sheath of the tibialis anterior muscle, thickening of synovial membrane in the joint between the cuneiform and the metatarsal bones at the site of the tibialis anterior muscle tendon attachment, probably brought about by the inflammatory process, uneven outlines of the calcaneal tuberosity, and slightly hypo- echogenic site of the calcaneal Achilles tendon attachment. Orthopaedic consultation followed. Taking into consideration the patient's history, Ultrasound and X-ray examination results, chronic inflammation of the left Achilles tendon attachment to the calcaneal bone was finally diagnosed.

The patient was treated with Amoxiklav 1,0g b.i.d. for 7 days and then 0,5g b.i.d. for 6 weeks, Naproxen 0,25 g b.i.d. and gastric protective drugs. .

Discussion

This case is presented as a reminder of the possibility of two different loco-motor system diseases being present at the same time, where signs and symptoms of the one camouflage the other on-going process. In this case presented, there were signs and symptoms of sciatica due to post-traumatic discopathy which masked the problem of the reactive talo-crural joint and left calcaneal tuberosity inflammation. Not enough attention had been paid to the elevated values of the inflammatory markers, which are not characteristic of post-traumatic discopathy. Thermography is a very good method for the visualization of temperature differences which are so characteristic of the inflammatory processes (3,4).

Although diagnostic imaging of the spine and both ileo-sacral joints had revealed normal findings without signs of inflammation, family history have been inconclusive for spondylarthropathies in relatives, and HLAB27 had been found to be negative, this patient should remain under continuous medical scrutiny in order to detect early signs of ankylosing spondylitis. The enthesitis of the Achilles tendon is a typical extraspinal manifestation of spondylarthropathies (5). The onset of ankylosing spondylitis prior to the 15th year of life is characterized by peripheral arthritis in almost 100% of patients, particularly at the lower extremities. In a previous study only 20% of patients who presented initially with low back pain and one of four extra-articular signs associated with spondylarthropathies (peripheral arthritis, heel pain, uveitis, elevated ESR) did not develop ankylosing spondylitis during a 10 years follow-up (7).

Clinical signs such as swelling and reddening of the ankle and forefoot, increased temperature of the affected region measured by thermal imaging and thickening of the synovial menbrane in some foot joints in the ultrasound examination, have confirmed the occurrence of peripheral arthritis and enthesitis. For a male adolescent, both findings must be regarded as a risk for the development of a disease from the group of seronegative spondylarthropathies, and further observation is therefore warranted.

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Abstracts

THERMAL IMAGING AS AN OUTCOME MEASURE

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Outcome measure are defined as the systematic collection (usually prior to and following an intervention) and analysis of information that is used to evaluate the efficacy of an intervention. Various types of outcome measures exist such as patient-completed self-report questionnaires, clinician- completed observation scales, task-specific activities -tests e.g. sit to stand, tests to assess body structure and tests to assess body function. Thermal imaging must be understood as a technique that images function, but not body structure e.g. anatomy.

Common requirements of outcome measures are must been published in a peer-reviewed journal, requires a standardised procedure and written scoring procedure. The outcome measure must be appropriate, reliable, valid, responsive (i. e. sensitive to change), interpretable, acceptable and feasible. For each requirement examples related to thermal imaging will be discussed.

Thermal imaging was already used as outcome measure in trials of acupuncture for facial paralysis, physical therapy and drug treatment of Complex Regional Pain Syndrome, physical therapy of tennis elbow, exercise treatment of Thoracic Outlet Syndrome, lymphatic drainage of lymphedema, surgery for osteo. arthritis of the knee, exercise treatment of low blood pressure in children and drug treatment of occlusive arterial disease.

Thermal imaging meets all requirements for an outcome measure and may be used in clinical trials to assess the efficacy of interventions.

USEFULNESS OF EXPONENTIAL MODELS IN ESTIMATION OF THERMAL PROPERTIES OF BIOLOGICAL MATERIALS IN ACTIVE DYNAMIC THERMOGRAPHY

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In active dynamic thermography (ADT) the simplest one-exponential model described by thermal time constant is being used for evaluation of biological tissues thermal properties. Thermal conductivity, specific heat and thermal diffusivity are basic thermal properties while the thermal time constant is indirectly characterizing such properties. Solving heat transfer equations, assuming the simplest geometry and boundary conditions, the proportionality relation between the thermal time constant and the thermal diffusivity is valid.

For active dynamic thermography measurements and respective MATLAB numerical simulations the relations between the thermal time constant and basic thermal properties are determined. Usefulness of a multi-exponential model (a modified version of the oneexponential model) in estimation of the thermal diffusivity is shown. The nature of a nonlinear distortion of the relation between the thermal time constant and the thermal diffusivity is discussed. Such analysis may be of some importance in evaluation of practical validity of ADT experiments.

HYPERTHERMIC AREAS IN THERMAL IMAGES

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Hyperthermic areas within medical thermal images may be caused by inflammation, increased blood flow, growing tumor, heat generation due to muscle contraction or artefacts due to the environment. Examples will include inflammatory joint disease such as rheumatoid and osteoarthritis, inflammation of tendon insertions and tendon sheets and bursitis. In Paget´s disease of bone hyperthermic areas have been related to increased blood flow within the affected bone.

Skin inflammation caused by herpes infection, skin rash due to virus infection, irradiation induced dermatitis will be presented. Varicose veins and deep venous thrombosis are related to hyperthermic changes. A diffuse hyperthermia on the diabetic feet may be caused by neuropathia, an intensive local hyperthermia was related to underlying osteomyelitis.

Malignant tumours of the female breast or of the skin such as melanomas can be visualised in thermal images as hyperthermic areas. These “hot spots” might be caused by an increased angiogenesis.

Recently conducted muscle work, muscle spasms and tender points in fibromyalgia patients are all characterized by increased skin temperature. Artefacts due the environment such as heating by infrared radiation, conductive heat therapy or skin contact with other hot surfaces can result in hyperthermic areas on the body surface

ENHANCED LASER-TISSUE INTERACTION USING INFRARED THERMOGRAPHY

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The application of infrared thermographie methods in laser-tissue interaction continues to grow in signifieanee. The development of portable lasers has increased the application of laser therapy and in some cases the number of laser operators. The efficacy of manually operated lasers and treatment protocol is largely dependent on the skill of the operator including optimizing laser parameters. Therefore infrared thermography is able to enhance efficacy and reduce the incidence of unwanted side effects by:

. optimising laser parameters prior to therapy,

. monitor laser -tissue interaction during laser therapy and

. during computerised laser scanning of tissue.

Thermographic intervention will reduce the occurrence of excessive heating, missed treatment areas and reduce pain.

Alongside developments in laser technology is miniaturization and reliability of thermal detectors and improvements in display technology. It is envisaged that in the future smart laser devices will evolve with integrated thermographic capability. This paper begins this process by comparing thermographic results taken fom the skin surface during manual and computer laser scanning. These results are compared to a Monte Carlo model.

SKIN TEMPERATURE AND LASER DOPPLER FLUX IN HEALTHY ADULTS: REFERENCE MEASUREMENTS AND DEGREE OF CONTRALATERAL ASYMMETRY AT SIX BODY SITES.

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Background A protocol for the assessment of inflammation in childhood localised scleroderma plaques* was adapted to obtain reference readings for skin temperature and laser Doppler flux at six body sites from 7 adults (4F, 3M). All subjects gave informed consent to participate in the study, which was approved by the Ethics Committees of the Great Ormond Street and Royal Free Hospitals.

Method : For each subject triangular aluminium foil markers were applied to the skin at 6 body sites (arm, leg, abdomen, back, cheek and forehead) and at a further 6 precisely contralateral sites. The subject then acclimatised at a room temperature of 23 ± 1°C for ten minutes. Standard thermographic views of all marked body sites were then captured with a Flir SC500 Thermacam thermal imager. Ten seconds of laser Doppler flux data were recorded sequentially adjacent to the tip of each triangular marker (Moor Instruments MBF3D blood flow monitor, 810nm). The sequential laser Doppler readings were then repeated twice more for each body site, and the mean laser Doppler flux over the 3 measurements at each site was calculated. The skin temperature at each body site was determined by defining a square region of interest of dimension 2cm x 2cm positioned at the tip of each triangular marker in the thermograms (Flir Thermacam Researcher 2002 image analysis software).

Results The hottest body site was the forehead, which also showed the least inter-subject variability (mean T = 34.2°C, SD = 0.3°C). The coldest site was the leg (mean T = 31°C, SD = 0.9°C). The cheek had the greatest inter-subject variability (mean T= 32.6°C, SD = 1.5°C), and this was also the site with the greatest mean asymmetry between contralateral measurements (0.5°C, SD = 0.3°C). The leg was also the body site with the lowest laser Doppler flux (mean = 9.3 AU, SD = 1.7 AU). The cheek exhibited the highest flux, and the greatest inter-subject variability (mean = 57.6 AU, SD = 38.2 AU). We defined a laser Doppler "asymmetry index" by taking the absolute value of the difference in flux between contralateral sites, and dividing it by their mean value. This index was found to be greatest at the cheek with a mean value of 0.34 (SD = 0.34).

Conclusion Our data confirm the variation of skin temperature between body sites. The findings also support the previously published assumptions that contralateral differences of more than around 0.5°C should be considered abnormal.

Laser Doppler readings were low in the periphery and lower limbs, and high in the head, as would be expected due to orthostatic factors. The data also suggest that variation in flux readings between contralateral body sites of less than about 50% is entirely normal. Findings in the cheek support our impression from clinical cases that temperature and flux can be quite asymmetrically distributed in some areas of the face, and there is also large inter-subject variability in the readings. Our flux and temperature readings from the forehead, however, showed acceptable inter-subject variability and symmetry.

Further work is required to validate reference ranges for the thermography and laser Doppler techniques. In particular, "normal" skin temperature and laser Doppler flux readings may be dependent on age, sex and body weight.

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Visentin M, Howell KJ, Lavorato A, Jones CD, Martini G, Smith RE, Denton CP, Zulian F, Black CM, Harper JI and Woo P. Is thermography a sufficient tool to detect active disease in juvenile localised scleroderma? (Poster). 8 International Workshop on Sclerodrma Research, 1st-4th August 2004, Trinity College, Cambridge, UK.

ADVANCED THERMAL IMAGE PROCESSING – IMAGE FEATURES AND CLASSIFICATION

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In this paper we present classification of the thermal images in order to discriminate healthy and pathological cases. As an example breast cancer thermal images were used for verifying the proposed method. Different image features and approaches for data reduction and classification have been used. The most promised method was based on wavelet transformation and nonlinear neural network classifier.

Thermal image classification is a powerful tool during breast cancer screening. At the Technical University of Lodz, in Institute of Electronics, the software for calculation image features, their selection and processing, as well as classification algorithm has been developed. Among the variety of different image features, statistical thermal signatures (1st and 2nd order) have been already effectively used for classification of images represented by raw data. In the research presented here some new features based on wavelet transformation was introduced.

It is possible to define hundreds of features for an image, and obviously, the selection and reduction are needed. Two approaches were applied in this work, based on Fischer coefficient and by using minimization of classification error probability (POE) and average correlation coefficients (ACC) between chosen features. It can reduce the number of features to a few ones, maximum to 10. The next step is the features preprocessing which generates new parameters after linear or nonlinear transformations. It allows to get data which less correlated and of the lower order. Two approaches were used in the research, i.e.: PCA (Principal Component Analysis) and LDA (Linear Discriminant Analysis).

Finally, classification was performed using different Artificial Neural Network (ANN), with or without additional hidden layers, and with different number of neurons. Additionally, we have compared ANN classification with widely used Nearest Neighbour Classification (NNC)

THERMOGRAPHY AS AN OUTCOME MEASURE IN RHEUMATOLOGY

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The term rheumatology embraces as wide range of musculoskeletal and articular joint diseases. In many of these clinical conditions, inflammation is present. Unlike acute inflammation, which may be localised and may be naturally resolved, chronic inflammation leads to systemic complications and tissue destruction.

Early research in Bath UK in the 1960-1980's focussed on the fundamental issues of objective assessment of chronic inflammatory diseases. These studies showed that when the skin temperature over an inflamed joint was raised, this was often a sign of deeper inflammation, which could be detected in a number of ways. Arthroscopy of joints, biochemical markers especially those measured from synovial fluid, and clinical signs of joint swelling pain and stiffness are all used to investigate arthritis. We were able to show that the measurement of skin temperature over a joint was an effective and non-invasive means of monitoring the level of inflammatory activity in each selected site on the body. The technique, using a thermal index for quantification, was used to monitor differing doses and differing analogues of prednisolone. The technique was also useful for the quantification of response to oral non-steroid drugs, and the more powerful anti rheumatic drugs. In Paget's disease of Bone, intermittent dosage with bisphosphonates could be monitored by thermography to determine optimum dose and frequency of intermittent treatment required for each patient.

These studies provided valuable understanding of the manner in which some of the anti-inflammatory agents worked. At low dose, frequently showing complete absence of side effects, the oral non-steroid drugs were purely analgesic in their action. As the dose increased, anti-inflammatory action and decrease of joint temperature was observed, more rapidly in the small affected joints such as fingers, and more slowly with large joints such as knees and ankles. I was possible to carry out dose response curves in both experimental animals (stage 1) and on patients (stage 3) of a new drug development.

This procedure, as with al, quantitative studies, requires a rigorous clinical routine, and stable and controlled room temperature, and large numbers of subjects Thermography is still one of the very few techniques which can be used for clinical trials as well as on animal models of inflammation for new drug development. Detecting a non-responder to a non-steroid drug as early as possible in clinical treatment has clear advantages for both patient and physician.

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THERMOGRAPHIC ASSESSMENT OF THERMAL EFFECTS OF ER:YAG LASER IN PERIODONTAL SURGERY

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Introduction: Lasers in dentistry have been applied to many procedures, i.e. soft tissue cutting applications, removal of carious lesions, laser-assisted scaling or disinfection of root canals. One of the most effective instruments for dental soft tissue surgery is the CO laser. Despite its unquestionable advantages, the numbers of studies are undertaken to developed a new devices based on lasers of erbium-type, with ability to cut the dental soft tissue. Due to the advantages of CO laser i.e. precise of incisions or healing without scaring, the Er:YAG laser has been proposed for various types of oral soft tissue surgery. The superiority of the Er:YAG laser to CO laser is the elimi- nation of damaging thermal effect during dental hard tissues procedures.

The uses of dental devices with erbium laser for various procedures like the removal of carious lesions have been explored for several years. With the development of fiberoptic contact delivery system for Er:YAG laser it can be used for many others treatment procedures. To confirm usefulness and effectiveness of Er:YAG laser for intraoral soft tissue surgery a number of clinical research are still carried out.

Methodology: The investigations were carried out on Wistar rats. After administration a general anaesthesia animal was stabilized on the lab table. The Er:YAG laser system (model 1243 KaVo KEY) was used. Intraoral soft tissue surgery of frenectomy, frenulectomy and excision of lingual mucosa was performed.

Thermographic measurements were carried out under carefully controlled external operating environment. The room temperature was maintained at 20C and was controlled automatically by air-conditioning. In view of high dynamic of temperature changes at the time of laser irradiation, thermal imaging camera ThermaCAM SC3000 (FLIR Systems) was used. Thermal images were taken at a very high rate of 750 frame/sec.

Results: Heating of fiberoptic tip at the time of laser-assisted frenectomy and frenulectomy was analyzed because of high temperature rises observed. The mean temperature of the end-point of optical fiber at laser energy of 100mJ and repetition rate of 25Hz over a period of 0,7sec reached 350°C, and then the temperature ranged from 270°C to 360°C. The maximal temperature observed was 500°C.

Furthermore dynamism of thermal changes on the surface of oral mucosa at the time of laser application was analyzed. The rise in temperature higher than 50°C pegged at about 0,4sec. The maximal temperature recorded on the surface of operation area was 238°C, but the time of influence of temperature higher than 100°C was at about 100 milliseconds. Continual rise of minimal temperature was observed. This phenomenon occurred because of indispensable time for relaxation of thermal stimuli. Another step of analysing was distribution of temperature of the surgical area along selected line at maximal rise of temperature. The rise in temperature above 50°C at energy of 100mJ was recorded on the length of 2mm and at en energy of 300mJ – 3mm respectively. The increasing of laser energy resulted in temperature rises of about 25% (from 230°C to 290°C) on the surgical field.

The maximal temperature registered on the surface of tongue during procedure of lingual mucosa excision was 200°C at laser energy of 80mJ, moreover the rise in temperature above 40°C was observed on the length of 1,6mm of the operation area. For laser irradiation et energy of 160mJ the maximal temperature reached 230°C and the rise above 40°C was observed on the length of 2,5mm. The rate of cooling for both cases was lower than 0,5sec.

Conclusions: Side effects of heating (up to 80°C) the end point of optical fiber as well as the surface of oral mucosa observed in experiment did not cause persistent histological changes in course of healing.

To prevent undesirable thermal side effects and overheating of operation area optical fiber should be moved very fluently, without contact with tissue.

Results obtained in this study suggest, that thermal imaging system can be a useful tool for monitoring thermal effects of Er:YAG laser/tissue interaction during periodontal procedures.

Acknowledgments. We would like to thank FLIR Systems Company for facilities of thermal imaging camera ThermaCAM SC3000 for our investigation.

DYNAMIC THERMOGRAPHY AS A DIAGNOSTIC TOOL FOR MEDICINE

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In this paper the basis of lock-in and pulse thermography are presented, showing both potentialities and limits of this method, especially for medical applications. Active thermography is the method where a sample is heated by an external energy and thermal response is measured. While the process is dynamic, the sequence of temperature distributions can be used for material parameter estimation. In many publications this method was successfully applied for solid materials and thin film measurements. In biology and medicine active thermography methods can be applied for measuring skin thickness, inflammation regions, density of tissues, blood flow, etc.

Lock-in thermography assumes the periodic excitation on the front side of the investigated body and synchronous thermal image acquisition. Such a case can be theoretically described as a fluctuating heat flux transferred to/from the front face of the sample. The flux can be generated in different ways, typically using radiation power obtained from high-power lamp. Pulse thermography is using single shot excitation, and the temperature rise and decay are measured. By using pulse or lock-in thermography, one can measure e.g. the thickness of the thin film coating or rusted areas, mainly in invisible places. The typical thickness measurement by active thermography assumes that it is of the order 30-150?m, depending on the substrate and coating thermal properties.

MEDICAL INFRARED THERMOGRAPHY AND THE MEDICAL DEVICES DIRECTIVE: WHAT CAN BE LEARNT FROM PUPILLOMETRY.

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Under the European Union medical devices directive (MDD) (93/42/EEC), a medical device is defined to include "any instrument, apparatus, appliance, material or other article, whether used alone or in combination, including the software necessary for the proper application, intended by the manufacturer to be used for human beings for the purpose of diagnosis, prevention, monitoring, treatment or alleviation of a disease, an injury or a handicap".

Under this directive any device put on the market with the intention for it to perform a measurement on a patient must now comply with the requirements of the directive: it must be CE marked to the MDD

We will take as an example the infrared pupillometer. This is a device for measuring the size of the pupil of the human eye in any ambient light levels. The eyes are bathed in near infrared radiation and by means of suitable optics and a CCD camera, an image of the eye is created. Software extracts parameters from the image such as pupil diameter. Stimuli, for example light pulses, can be applied to interrogate neural pathways and a dynamic sequence obtained. Asymmetry between left and right eyes also provides valuable information. Primary applications are the measurement of resting pupil diameter prior to refractive laser surgery and investigations into autonomic function. The Procyon P3000 binocular infrared static and dynamic pupillometers are CE marked to the MDD

Excepting that Infrared thermography utilises endogenous radiation there are many parallels with pupillometry. Both are non-contact (except for patient supports), produce an image of the body, from which software derives an absolute measurement (length, temperature) which is used to make diagnostic and therapeutic decisions. Both techniques employ stimuli to obtain dynamic responses, and contralateral asymmetry is of interest.

However, the thermographic cameras used by the medical community are not sold as medical devices. In particular they do not meet IEC601-1, the standard for electrical safety of medical devices.

We will argue that a thermographic camera used for patient measurement should be considered to be a medical device. We will discuss the commercial issues around CE marking to the MDD. Finally, we will outline the need for adequate and sufficient risk assessments to be in place in medical thermographic laboratories to ensure patient safety with currently available thermographic cameras. Central to the assessment is that there is an traceable record of temperature accuracy and image quality. We will also recommend the use of standard operating procedures coupled with a library of standard views.

THE EFFECT OF WATER FILTERED INFRARED-A IRRADIATION (WIRA) OF THE ABDOMINAL WALL ON SKIN TEMPERATURE AND SKIN BLOOD FLOW MONITORED RESPECTIVELY BY INFRARED THERMOGRAPHY AND SCANNING LASER DOPPLER IMAGING.

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Introduction A major advance in reconstructive surgery has been the success of free-tissue transfer. Although success rates greater than 90% are normal with microvascular free flaps, surgeons continue to be confronted by occasional flap loss. The most common denominator of flap loss is prolonged ischemia, which causes irreversible tissue damage and complicates reconstructive surgical procedures. Heat shock priming has shown to increase the tolerance of tissue for ischemia and is defined by the temporary exposure of cells to supra-physiological levels of heat. After recovery cells become, in response to this heat shock, more resistant against a second stress, including surgical trauma and ischemia. Heat shock priming is known to protect flap tissue also after tissue transfer and can therefore be used to precondition the flap. This study investigates the effect of water filtered infrared irradiation (wIRA) from a Hydrosun® wIRA irradiator (Hydrosun® Medizintechnik GmbH,Germany)of the abdominal wall on skin temperature and skin blood flow. The lower abdominal wall is a frequent used donor area for free flaps. If supra-physiological levels of heat are obtained by wIRA irradiation then it could be used to precondition flaps.

Methods: Ten healthy female volunteers (age 37.1 ± 7.9 years; BMI 22.8±1.8) participated in the study. The lightly clothed subject lay in a supine position on a conventional treatment bench at a room temperature of ca 23°C. The treatment con- sisted of a 20-minute period of wIRA irradiation of the abdominal skin on the right side with the left side covered during treatment. Abdominal skin temperature and skin blood flow (SBF) were measured respectively using infrared thermography (Nikon Laird 270 infrared camera, Nikon ltd., Japan) and a scanning laser Doppler (MoorLDI-2 laser Doppler imager, Moor Instruments ltd; England). Measurements were made before, and at 0, 5, 10, and 15 minutes after the period of wIRA treatment. During measurements (before and after irradiation), the coverage on the left side was removed to allow bi-lateral measurements of SBF and temperature.

Results: Before irradiation, SBF was on average 70 PU (perfusion units) and average skin temperature was 32.5°C. At the end of the irradiation period, SBF on the irradiated side of the abdomen had increased over 10 fold to ca. 710 PU while skin temperature increased by 4.5°C to 37°C. SBF on the non-irradiated side of the abdomen did not change during the wIRA period, while skin temperature increased by about 0.5°C. Both SBF and skin temperature on the irradiated side decreased in parallel during the post-irradiation period although both were still greater than their respective pre-irradiation values at 15 min post-irradiation (ca. 200 PU and 34.2°C respectively).

Discussion: The results clearly show that wIRA provides a rapid and powerful means of increasing skin temperature as well as increasing skin blood flow. The significant rapid increase in perfusion will most likely be beneficial in a model where the flap is pre-conditioned with alternate cooling and warming, as has been previously demonstrated.

Conclusion: wIRA irradiation of the skin with a Hydrosun® wIRA irradiator causes a significant increase in skin temperature and skin perfusion.

DYNAMIC THERMOGRAPHY AS A RELIABLE, NON-INVASIVE AND EASY METHOD FOR MONITORING PERFUSION IN FREE FLAP SURGERY, PRELIMINARY RESULTS.

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Introduction: The use of free flaps in reconstructive surgery has become common practice. A good example is the use of the Deep Inferior Epigastric Perforator (DIEP) flap for breast reconstruction after surgical treatment for breast cancer. The DIEP flap consists of skin and subcutaneous tissue from the lower abdomen and relies for its blood supply on the deep inferior epigastric artery and vein. During free-flap transfer, both the artery and vein are separated from the parent vessel which results in cessation of blood flow to the flap. After transfer of the flap to the thoracic wall, the surgeon connects the flap's artery and vein to respectively the internal mammary artery and vein. The connection, called the microvascular anastomosis, is the most critical procedure during the operation. Reperfusion of the DIEP flap is dependent on the viability of the anastomosis. Monitoring flap perfusion intra- and postoperatively has proven to reduce partial and complete flap loss, which can be a devastating experience for a patient. In this pilot study, dynamic infrared thermography was used intra- and postoperatively to monitor the blood flow status of the DIEP flap used in breast reconstruction.

Methods: Eight patients undergoing breast reconstruction with a DIEP flap were included in this study. Intraoperative infra-red thermal images of the DIEP flap were taken before and after the microvascular anastomosis was completed to monitor active re-warming of the flap. Afterwards, dynamic thermography was used to monitor re-warming after an intraoperative thermal challenge with surface cooling. In the days, weeks and months after the operation dynamic thermography monitored re-warming after a short period of fan cooling. All IR-images were taken using a Nikon Laird S270 (Tokyo, Japan) IR-camera. For processing the electronically stored IR digital images we used image analysis software PicWin-IRIS (EBS system technik GmbH, München, Germany).

Results: The thermal images showed that the flap cooled down after cessation of the blood flow. Rapid, active re-warming of the flap started from one "hot spot" in the flap after the anastomosis was completed and patent. This was followed by appearance of other hot spots. A clear arterial Doppler signal could be heard over these hot spots. Re-warming of the flaps could be well distributed and in these cases no perfusion problems were seen postoperatively. Re-warming of the flap was improved by anastomosing an extra vein for drainage of the flap. No hot spots appeared when the anastomosis did not function or with external compression on the vessels. A new anastomosis or repositioning of the vessels was followed with active re-warming of the flap. The postoperative phase showed an initially rapid re-warming during dynamic IR-thermography that became less profound in the weeks and months that followed. Visualization of the indirect blood flow with IR-thermography was highly appreciated by patients and experienced as an assurance of the success of the operation.

Conclusions: Rapid active re-warming in free flap surgery is only possible by perfusion. The use of dynamic IR-thermography provides the surgeon a new, reliable and non-invasive method for monitoring perfusion during and after a free-flap transfer.

INTERMITTENT ISOMETRIC CONTRACTIONS OF THE RECTUS ABDOMINIS MUSCLE BY APPLICATION OF TRANSCUTANEOUS ELECTRICAL NERVE STIMULATION (TENS) AND ITS EFFECT ON SKIN TEMPERATURE AND BLOOD FLOW IN THE OVERLYING SKIN.

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Introduction: Breast reconstruction has become an integrated part in the overall treatment for patients diagnosed with cancer of the breast. Patients with autologous breast reconstructions with a free transverse rectus abdominis musculocutaneous (TRAM) or deep inferior epigastric perforator (DIEP) flap are specifically pleased with the natural shape, soft consistency and permanency of the superior results. However, there is a recognised incidence of partial flap necrosis in both the TRAM and DIEP flaps. The main blood supply of both flaps is the deep inferior epigastric artery. It is the dominant artery of the rectus abdominis muscle and only musculo-cutaneous perforators arising from this artery provide blood to the free TRAM and DIEP flap. Muscular blood flow can increase up to 25-fold during extreme physical activity. The increase in blood flow elicited by voluntary and electrically induced muscle contractions by transcutaneous electrical nerve stimulation (TENS) appear to be similar in magnitude. An increased blood flow in the contracting muscle could result in an augmented flow through the myocutaneous perforators to the skin. This could be a non-invasive method of preconditioning the TRAM or DIEP flap for autologous breast reconstruction and could augment the volume that can be used in breast reconstruction. However, there are contradictory reports on the effect of TENS on skin temperature and cutaneous blood flow ranging from no effect to an increased microcirculation in skin areas overlying stimulated muscle. In this study, the effect of burst-mode TENS of the rectus abdominis muscle on the microcirculation in the skin was investigated. This pattern of external stimulation more closely mimics the intermittent muscle contractions during, for example, sit-ups.

Methods: In ten healthy female volunteers, average age 37.1 ± 7.9 years and average BMI 22.8 ± 1.8, two pairs of oval shaped stimulating surface electrodes (50mm x 100mm), each with a surface area of 39.3cm, were placed on the abdomen. One pair was situated on the right side and the other on the left. Skin temperature and skin blood flow were measured with respectively, infra-red thermography using a Nikon Laird S270 (Tokyo, Japan) IR-camera.and laser-Doppler imaging (Moor LDI-2 laser Doppler imager; Moor Instruments ltd; England) before, during and after intermittent isometric contractions of the rectus abdominis muscle. During the experiments, only the left electrode pair was stimulated. By increasing the intensity (0-40 mA), visible intermittent muscle contractions were evoked. Each patient was subjected to a 20-minute period of stimulation. To examine the possible effect of TENS on skin surface temperature, either directly through increased skin blood flow or indirectly via heat conducted to the skin surface from the stimulated muscles, the average skin surface temperature of two identically oval shaped areas (ca. 26 cm) was calculated. The scanning laser Doppler (SLD) was adjusted to cover an area of approximately 360 cm, which included all 4 TENS electrodes. In each experiment scans lasting ca.90seconds were made prior to the start of TENS stimulation, immediately after the end of TENS, and at respectively 5, 10 and 15 min of the recovery period following TENS. For each SLD image two 20 cm rectangular areas of skin lying between each lateral pair of electrodes were used for calculating average skin blood flow in perfusion units (PU).

Results: No significant changes in skin temperature were found while minor changes in skin blood flow (SBF) (a decrease in SBF on the stimulated side) were registered.

Conclusion: It is concluded that burst-mode TENS does not increase blood flow in the skin overlying the stimulated muscle and is unlikely to precondition the DIEP flap.

THE METHOD OF ANATOMICAL POINTS SELECTION IN THE FACE THERMOGRAM.

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Objectives. The aim of paper is a presentation of the method suggested for anatomical points selection in the face's thermogram.

Image analysis has been a main point of interest of many scientists for many years. They usually have worked on the graphic file like bitmap, where natural scene described as R, G, B values have been used as a source for analysis. A different situation exists in the analysis of thermograms , where we usually work with pseudo images – the graphical representation on the temperature distribution on the surface. This means that the thermograms of the same object can be presented differently dependant on colour function and may generate different R, G, B values.

The proposed method is independent of colour function and can be useful in a automatic face's thermogram analysis software.

Methods. The base for this method is an analysis of the temperature matrix as a result of the single man observation. It means, it is possible to select in the scene the man and some others object in the background. Analysis can be divided in to 4 steps named: Filtration, Head searching, Head area analysis and Anatomical point selection.

The aim of first step is to remove all data from the temperature matrix which represent with high probability objects outside of the face or have unknown temperature values. This value is typically reported by the thermographic camera as a "Not a Number" value. At the end of this step image area of interest is decreased.

The "Head searching" is based on isotherm processing. The isotherme matrix processing generates data which are the base for the best fitted ellipse.

"Head area analysis": this step removes all data from the matrix data which are outside of the outline of the head and generates the mask for the next processing step.

During the last one "Anatomical point selection" step we used basically one of the standard filter methods such as Sobel, Previtt, Roberts and Canny filters. 256 level black & white, thermograms were the source for filtering. In many cases these filters generate a set of points which cab be useful in the next step of analysis. But there also many thermograms where these filters work incorrectly.

Our suggestion is based on image processing of a filtered temperature gradient matrix. During this process, some isotherms are removed lines, if the enclosed area is smaller or greater than empirical values . After this, the second step of filtration is made. This step is based on the geometrical relation between position of the eyes and nose to the outline of the head.

At the end. a set of anatomical points is presented as a matrix of coordinates.

Results: We have tested the presented method in a pilot study with 32 thermograms from people of different age and gender with good results.

In a second study the proposed method was tested in series of thermograms from 12 different subjects.. For each subject a series of 27 thermograms was recorded consisting of 9 views from 3 distances [1, 2, 3m]. The method works correctly in most of the cases.

Problems has been observed when the distance was equal to 3m and when the object (head of the subject) was rotated or the the view of the recording camera was not perpendicular to the object.

Conclusions: The presented method may be useful for image processing of facial thermograms. It can be specially useful for the identification of the position of the eyes and the nose. This method may be helpful in the generation of automatic systems for the evaluation of facial thermograms for example in patients suffering from maxillary sinusitis.

LIQUID-CRYSTALLINE CONTACT THERMOGRAPHY IN MEDICINE

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The physical background of liquid-crystalline thermography (LCT) and some information regarding the technology will be presented. This will inc1ude the effect of selective light reflection and the influence of body temperature as weIl as the properties of thermographic foils on the colour of reflected light. The measuring technique, moreover advantages and disadvantages of the LCT will be discussed in details with the special attention paid to the effect of the environment. The review of studies on medical applications of LCT will be given. In the summary the comparison between LCT and thermovision systems will be given, moreover the perspective of LCT application in practice will be proposed.

RENAL FISTULA ASSESSMENT USING COMBINED THERMAL IMAGING AND COLOUR DUPLEX ULTRASOUND

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Vascular and clinical assessments of fistula function are important in patients undergoing or preparing to undergo renal dialysis. Objective assessments at Freeman Hospital now indude 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 fIow which can result in vascular steal (digital blood fIow impairment resulting in skin temperature reduction). The aims of this pilot study were a) to determine if fistula region skin temperature is related to fistula blood fIow and b) to determine if simple bilateral differences in hand temperature relate to clinical steal grading.

Renal patients were clinically assessed for vascular steal by the transplant surgeon (either steal or no steal). Patients also underwent objective vascular measurements which comprised thermal imaging of the hands and fistula region followed by fistula blood fIow estimation using colour duplex ultrasound at the brachial artery. Differences (fistula - non-fistula side) in the mean hand temperature and in the mean I maximum fistula region temperatures were determined using dedicated image processing software (FLIR SC 300 thermal imaging system with ThermaCam Researcher image processing software, skin emissivity 0.97). These temperatures were then compared with fistula flow and steal grading.

Fifteen patients were studied (mean age 60 years), with flVe dassed as having some degree of clinical steal. Ultrasound measurements also identified the presence of stenosis in 5 patients. Estimated fistula flows ranged from 30 - 1950 ml min-1 (mean [standard deviation] of 920 [680] ml min-1) and were significantly correlated with bilateral differences in maximum fistula region skin temperature (R = +0.71, p<0.01). Therrnography usually deany highlighted the warmer superficial blood vessels in the region of the fistula (mean 33.3 [1.1] °C, maximum 35.3 [1.0J °C). Hand temperature differences with threshold set to -1 °C were found to separate steal from non-steal patients with an accuracy of 93.3% (specificity 100%, sensitivity 80%). In this study the maximum difference between mean hand temperatures for a patient with steal was close to 5°C.

We have demonstrated an association between fistula region skin temperature and estimated fistula blood flow. We have also shown that a bilateral hand temperature difference with threshold of -1 °c separates steal from non-steal patients with an accuracy of greater than 90%. Further work is now needed to explore the dinical utility of these findings, to identify which patients subsequently needed surgery, and also to examine the detailed characteristics of the fistula thermal profiles.

THERMOGRAPHIC EXAMINATION FOR DIAGNOSIS OF ABDOMINAL PAIN IN CHILDREN

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Abdominal pain of children, is despite medical progress, still a difficult and complicated diagnostic problem. The type of pain, its localization and associated symptoms do not always lead to easy diagnostic decisions and demand the use of additional laboratory tests and diagnostic imaging. The aim of this study was to investigate the usefulness of thermographic examination (THV) as a screening method for the identification of the underlying course of abdominal pain in children.

Material and Methods. A prospective study was conducted in 46 children, aged 2 – 18 years, who were hospitalized at the Departments of Pediatrics of Silesian Medical University in Katowice, between from 2002 to 2003. All patients suffered from abdominal pain, usually chronic and with various localizations. A control group of 20 healthy children in the same age was also studied. The Flir System THERMACAM PM595 was used for thermal imaging, which was performed under standard thermal conditions. Prior to the readings of the thermal images, the investigator was blinded for clinical symptoms and pain localization.

Results. Only 4 of 46 children had normal thermal images (8,7%). Abnormal thermal images were found in the 42 children. Thermal abnormalities did not always correspond with abdominal pain and/or the localization of the affected organ. Hot spots were observed on the left hand side of the lower abdomen and/or a "patchy" image of the entire abdomen in children with functional disturbances of the alimentary tract or colitis. Warm areas corresponding with the anatomical localization were seen in children with liver and pancreas diseases. Hot spots on thermal images outside the abdominal region in 3 children, lead to the correct diagnosis (neoplasm in two patients, sinusitis in one).

Conclusions. The thermographic examination can be a useful screening method for the detection of the underlying cause in children suffering from of abdominal pain.

A COMPARISON OF SKIN TEMPERATURE AND OBJECTIVE SKIN COLOUR MEASUREMENTS IN NORMAL SUBJECTS AND PATIENTS WITH RAYNAUD'S PHENOMENON SECONDARY TO CONNECTIVE TISSUE DISEASE

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Raynaud's phenomenon is a condition in which the blood supply to the extremities, usually the fingers and toes, is intermittently interrupted. An attack can be triggered by exposure to cold, or even just a slight change in temperature. The affected parts become 'white', and may turn 'blue' and finally 'burning red', before returning to their normal colour. There may also be pain, numbness, or loss of hand function during an attack. Raynauds occurs in approximately 10% of the UK population. It is often severe when related to other conditions, such as connective tissue disease.

Traditionally, Raynaud's phenomenon is assessed clinically by careful examination and the reported episodic skin color changes. Some specialist centres also employ objective temperature measurements to aid diagnosis. However, these tests are not fully reliable since some healthy people can have generally cold hands and feet, without the characteristic episodic skin colour changes ascribed to Raynauds. It is hypothesized that objective skin colour determined using the optical technique of spectrophotometry may aid the diagnostic process. The aims of this pilot study were a) to compare objective skin colour measurements from normal subjects with patients having Raynaud's phenomenon secondary to connective tissue disease, and b) to explore possible relationships between skin temperature and colour.

A total of 24 normal healthy adult subjects and 24 connective tissue patients with clearly described Raynaud's phenomenon were studied. All were Caucasian. A single operator (JA) collected spot skin temperature and colour measurements from the palm and the pulps of the corresponding middle/ring fingers under normothermic conditions using an electronic thermometer (Comark 1601) and a portable reflection spectrophotometer (Minolta CM-508i, giving the percentage reflection between the visible wavelengths of 400 to 700 nm with 10 nm resolution), respectively. Normative ranges of skin temperature and colour data were calculated for the finger, palm, and differences between the finger and palm sites. The patient group was then compared with these data and differences tested using the Student's t-test (p<0.05 for statistical significance). Skin temperature and colour data were also compared to determine if these were related.

When patient skin colour data were compared against normative ranges (for patient - normal differences) 3 distinct points were observed for the finger site, with positive peaks at 480 nm and 580 nm, switching to a trough at 660 nm (p<0.005). Furthermore, a comparison of finger - palm differences between the groups revealed statistically significant differences for wavelengths greater than 600 nm (p<0.05) increasing p<0.0001 at 700 nm. When finger skin temperature and colour data were compared no clear relationship could be clearly identified for either subject group. When finger - palm temperature and colour differences were compared in normal subjects they showed only relative finger redness for positive temperature gradients. The connective tissue disease patient data appeared complex with no clearly discernable relationship.

Normative ranges of skin colour have been determined with specific and significant differences detected when compared to the connective tissue disease patient group. Interestingly, no clear relationships between skin colour and temperature data were found at the finger site for either group. Further work is now needed to explore these findings and also to evaluate the diagnostic value of spectrophotometry skin colour measurements in assessing patients with Raynaud's phenomenon.

THE COMPARISON OF THE THERMOGRAPHIC AND HISTOPATHOLOGIC STUDIES OF THE SKIN MELANOCYTIC NEVI

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The aim of the study was to compare thermographic and histopathologic analyses of melanocytic skin nevi. In addition, the mitotic activity of cells was analysed by the expression of Ki-67 antigen in histopathological studies of few melanocytic nevi which showed temperature changes in the thermographic study.

Material and Methods: In total, 160 melanocytic nevi from 35 patients were studied. These included 22 patients with a diagnosis of atypical nevus syndrome. The thermographic analyses were performed using Therma CAM TM SC 500 thermographic camera. The thermograms were analysed using AGEMA Report 5.41 computer programme. The differences between maximal (Tmax) and minimal (Tmin) temperatures within each pigmented lesion were calculated: $\delta T = Tmax-Tmin$. In 20 control subjects healthy skin without melanocytic nevi was studied. In the total group of 160 melanocytic nevi, the values of δT coefficients were 1.41 °C. In total 47 melanocytic nevi showed signs of atypy in the clinical and dermatoscopic examination and were treated surgically in the Department of Dermatology and Venereology of Pomeranian Medical University. Subsequently histopathologic examinations of the excisions were performed. For the evaluation of the mitotic activity in 15 melanocytic nevi, the expression of the Ki-67 proliferative antigen was studied histo-chemically. Ten melanocytic nevi with $\delta T > 1.41$°C and five melanocytic nevi with $\delta T < 1.0$ °C were evaluated. Additionally, in five cases of skin melanoma the expression of Ki-67 antigen was investigated.

Results: Mean value of δT coefficient for control group was 0.74±0.128 °C, whereas for 141 melanocytic nevi $\delta T < 1.41$ °C and for remaining 19 nevi - $\delta T > 1.41$ °C. The correlation between atypy in the histopathological examination and increased value of dT coefficients was noticed. For ten melanocytic nevi with $\delta T > 1.41$ °C, expression of Ki-67 was 1-9%, for 5 melanocytic nevi with $\delta T < 1.0$ °C the Ki-67 expression was 0-0.5%, whereas for 5 skin melanoma - 10-26%.

Conclusions: 1. Melanocytic nevi with $\delta T > 1.41$ °C in thermo. graphic study shows frequently histopathological signs of cell atypy 2. The elevated values of δT could be caused by the increased mitotic activity of melanocytic skin nevi.

THERMOGRAPHY IN PSORIATIC SKIN LESION EVALUATION.

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Psoriasis is a chronic, non-infectious inflammatory with polygenic component, skin disorder with a prevalence of 1- 2% of the human population worldwide. Increased blood flow resulting from elongation and widening of the vessel lumen together with inflammatory cell infiltrate are key features of histo-pat hological findings of this disease. The above phenomena lead t increased temperature of psoriatic skin lesions.

The aim of the study was to employ thermography in evaluation of skin lesions regression in patients hospitalized at the Department of Dermatology, Medical University of Lodz, Poland.

The study comprised 20 patients with psoriasis vulgaris who were on classical anti-psoriatic regimens. The thermocamera INFRAMETRICS 760 with temperature resolution of 0.1°C was used in the study. The examined patients were prepared undressed for 15 min in a specially designed room before each thermographic examination. Temperature measurements were performed every 7-8 days in a 21-28-day period.

During the treatment process progressing decrease of skin lesion temperature was noted. Dynamic of temperature changes was much higher than the dynamic of clinically evaluated parameters such as erythema, induration and desquamation.

It seems that thermography could become a sensitive parameter of psoriatic lesions progression/regression.

INITIAL RESULTS FROM THE THERMAL IMAGE DATABASE FOR CLINICAL THERMOGRAPHY

C. Jones,. EF. Ring,. P. Plassmann,

Medical Computing Research Group, University of Glamorgan, Pontypridd, UK.

Thermal imaging has been in use in medicine since the 1960's, despite many different applications and studies a normal database is not available. Presented here are the details of the construction of a normal database and a sample of the results.

To construct the database volunteers were recruited and screened for normality using the Euro-Qol (EQ5D) questionnaire, normal subjects were then imaged. Twenty four standard views of normal volunteers were recoded. Standard masks were used in each image to minimise variability in position between the subjects. Normal subjects were divided into categories, for example male's aged 18-30, so that images of the standard views could be combined. Before combining the images of different subjects, the images were warped to allow subjects of different shapes to fit exactly into the standard masks. The combined images provide information about the mean and variability of temperature in the standard views for a given category of normal subjects.

The results for the category of male's aged 18 –30, total body view, are discussed in detail.

Veranstaltungen (Meetings)

3 .4 Juni 2005

Kongress der DGTR e.V. in Mannheim

Information:

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June 22-24, 2005

14th International Conference on Thermal Engineering and Thermogrammetry (THERMO) Budapest, Hungary

Programme Chairman: Dr. I. Benkõ BME, DoBSE, Hungary (EAT, HST, President of TE & TGM)

Information:

Dr. Imre BENKÕ, H-1112 Budapest, Cirmos u. 1, 6/38, Hungary, Phone/fax: +361-310-0999.

E-mail: ibenko@freestart.hu

SCIENTIFIC PROGRAMME
(accepted papers till March, 2005)

Plenary lectures

S. Kakac [1], Y.Yener [2], W. Sun [1], T. Okotucu [2] ([1]University of Miami, Coral Gables, USA,[2]Northeastern University, Boston, USA) Single- phase convective heat transfer in micro-channels - State of the Art

Review

L. I. Kiss, M. Rouleau, L.(St-Georges Université du Québec a Chicoutimi, Québec, Canada): Determination of the thermal and electrical contact re- sistances at elevated temperatures

I. Dincer (Univ.of Ontario Inst.of Technology, Oshawa, Canada): Efforts to improve fuel-cell vehicles

F. Hamdullahpur (Carleton University, Dpt. O. Mech.and Aerospace Engng., Ottawa, Canada): Thermal and hydrodynamic aspects of drying in fluidized beds

1. Infrared imagery and analysis

O. Carpentier, E. Antczak, D.Defer, O. Ostrowski, B. Duthoit' (University of Artois,Technoparc Futura, Bethune, France): Void detection in civil engineering works by means of thermal impedance and 3D IR-thermography

Z.Hrytskiv, P.Kondratov (Lviv Polytechnic National University, Lviv, Ukraine): Optimization of frame-by-frame processing of pyrosignals for two-channel infrared camera

P.Bremond (CEDIP Infrared Systems, Croissy Beaubourg, France) Applications of infrared thermography in automotive industry- Benefices of new technologies

S.Filatov, G.Kuchinski, M.Dolgikh, E.Baturev (Heat & Mass Transfer Inst of NAoS of Belarus, Minsk, Belarus) Carbon nano materials plasma synthesis study by Raman and IR-thermography

C.Cuccurullo[1], G.Sorrentino[1], L.Ciquanta[2], V. Pierro[3] ([1]DIMEC, Univ. of. Salerno, Fisciano, [2] Univ.of.Molise, Campobasso, [3] Univ.of .Sannio, Benevento, Italy) Thermal field in microwave processing of foods

D.Guilhem, C.Balorin, G.Caulier, C.Desgranges, P. Messina, M.Missirlian, R.Mitteau, P.Moreau, C.Portafaix, N.Ravenel, H.Roche, A.Saille, P.Spuig (CEA-Cadarache, DRFC, Imagery and Diagnostics Group, St Paul lez Durance, France) Infrared thermography for real time feed- back control in Tokamak Tore-Supra

A.Willockx[1], H-J.Steeman[1] , G.DeMey[2], M.DePaepe[1] ([1]Dpt.o.Flow, Heat & Combustion Mechanics, [2]Dpt.o.Electronics .& Inf.Syst., Ghent Univ., Gent, Belgium) Analysis of natural convection and radiation by using thermography

2. Combustion and environmental protection

A.Tripathi[1], H.Chandra[1], M.R.Ravi[2] ([1]Madhav Institute of Technology and Science, Gwalior[M.P.], [2]Centre for Energy Studies, Indian Institute of Technology, Delhi, India): Determination of laminar burning velocity of liquefied petroleum gas -CO2-air mixtures

M.M.Safarov, M.A.Zaripova (M.S.Osimi's Tajik Technical University, Dushanbe, Tajikistan): Thermophysical aspect of ecology problems of contemporary rocket fuel

V.V.Ghia (Polytechnic Univ.of Bucharest, Romania) Determinative methodes of characteristics for fuel oil miniaturized combustion

J.Szurkowski (Univ.of Gdansk, Gdansk, Poland):Dependences of plants heat emission on environment pollution

M.A.Hamdan, A.Sakhrieh (University of Jordan, Dept.of Mech. Engng., Amman, Jordan): Inhibition of solid fuel dust explosion by burning mixtures of coarse and fine particles

I.Ionel, S.Ionel, D.Bisorca (Univ.PolitehnicaTimisoara, Romania:) Short-time spectra and correlation analysis of air pollution signals

A.Gungor, N.Ekin (Istanbul Technical.Univ., Istanbul, Turkey): Numerical computation of a circulating fluidized bed combustor and comparison with experimental results

T.Prisecaru, L.Mihaescu, M.Prisecaru, J.Mihaescu (Politehnica University of Bucharest, Fac.of Mech.Engng., Bucharest, Romania): Rehabilitation of a CR16 industrial steam boiler' gas burner towards environment protection

I.Benkö (Budapest Univ. of Technology and Economics, Hungary) Thermal pollution of the environment by power generation

3. Medicine and biology

E.D.Yildirim, B.Ozerdem (Izmir Inst.of Technology, Mech. Engng. Dept., Urla, Izmir, Turkey): The transient three dimensional passive thermal model of the human forearm

P.Drvis[1], D.Shejbal[1], S.Svaic[2], I.Boras[2], M.Susa[2], B.Pegan[1], L.Kalogjera[1] (1Dpt. Of Otolaryngology-Head and Neck surgery, Univ. Hospital 'Sestre milosrdnoice', Zagreb, Croatia, 2Univ. Of Zagreb, Croatia): The use of IR thermography for evalution of curaneous flap survival

I.Benkö (Budapest Univ. of Technology and Economics, Hungary) Thermogrammetry of the face among changing ambient conditions

G.Csóka[1], A.Gelencsér[1], S.Marton[1], R.Zelko[2], I.Klebovich[1] ([1]Pharmaceutical Inst.of Semmelweis Univ., [2]Univ. Pharmacy Dpt. of Pharmacy Administration, Semmelweis Univ., Budapest, Hungary): Fragility index determination of different Eudragit polymers used in transdermal therapeutic systems (poster)

A.Gelencsér[1], G.Csóka[1], S.Marton[1], R.Zelko[2], I.Klebovich[1] ([1]Pharmaceutical Inst. of Semmelweis Univ., [2]Univ. Pharmacy Dpt. of Pharmacy Administration, Semmelweis Univ., Budapest, Hungary) Thermoanalitical determination of thermoresponsive behavior of different Endragit polymers (poster)

4. Renewables

A.Midilli, M.Ay (Mech.Engng.Dpt., NigdeUniv., Nigde, Turkey): Parametric investigation of hydro-power generation in Turkey by using smal scale hydro-power plants

A.Bilgin[1], S.Sargin[2] (Suleyman Demirel Univ, [1]Fac.o.Arch.&Engng. [2]Fac.o.Sci.& Lit., Isparta, Turkey): Geothermal resurces in Afyon (Turkey) and surrounding area

A.Midilli[1], H.Kucuk[2] ([1]Energy Division, Nigde Univ., Nigde, Turkey, [2]Centr. Fisheries Res. Inst., Trabzon, Turkey): Experimental investigation of thin layer drying behaviour and conditions of the anchovy

M.Mohanraj, C.S.King, N.Lakshmanan (Dr.Mahalingam College of Engng.& Technology, Pollachi, Tamil Nadu, India): Reduction of greenhouse's gases emission in air-conditioning applications-A comparative study of renewable options

M.Karakilcik[1], I.Dincer[2] ([1]Dpt.of Physics, University of Cukurova, Adana, Turkey, [2]Inst.of Technology, University of Ontario, Oshawa, Canada): Performance investigation of a solar pond

I.Kovacsics(EGI-Contracting/Engineering Co. Ltd., Budapest, Hungary): Some practical aspects of utilising renewable energies in Hungary

5. Building services

S.Svaic, I.Boras, M.Susa (Univ. Of Zagreb, Fac. O. Mech. Engng. And Naval Architecture, Zagreb, Croatia): The estimation of the state of building using infrared thermography and numerical method

L. Kajtár, Sz.Vörös (Budapest Univ. of Technology and Economics,DoBSE, Hungary) Risk-based modelling of air conditioning systems

S.Gendelis, A.Jakovics (Fac.of Physics and Mathematics, University of Latvia, Riga, Latvia):Mathematical modelling of airflow and temperature distribution in living rooms

S.Gendelis, A.Jakovics (Fac.of Physics and Mathematics, University of Latvia, Riga, Latvia): Heat transfer measurements in non-stationary conditions for building structures (poster)

M.Taeibi-Rahni, M.H.Saidi, A.Nejatbakhsh (Sharif University of Technology, Tehran, Iran): Numerical modelling of a centrifugal pump at design and off-design conditions

N.Leonachescu[1], G.Rodan[2], F.Boian[3], P.Rodan[3] ([1]Techn.Univ.of Construction, 2National Institute of Aerospace Research, 3TEHNOSISTEM S.A., Bucharest, Romania): Physics of thermographical measurements in building industry

S.Alpay, B.Ozerdem, Z.Ilken (Izmir Inst.of Technology, Mech. Engng. Dpt., Urla, Izmir, Turkey): Computational fluid dynamics modelling of a draught diverted used in domestic water heating appliance

6. Thermomechanics and defectometry

A.El Maadi, V.Grégoire M.Jahanmir, L.Semlaji , Y.St-Onge, X.Maldague (Université Laval, Quebec city, Quebec, Canada): Application of TNDE for Shuttle's thermal protective system inspection

Y.-S. Son, J.-Y. Shin, S.-K. Kim (School of Mech.Engng.,Dong-Eui Univ., Busan,Korea):Parametric study on the thermal response of electronic assemblies during forced convection-infrared reflow soldering

M.D.Dramicanin[1], B.Jovanovic[2], A.Kapidzic[1] ([1]Inst.of Nuclear Sciences 'Vinca', Belgrade, [2]Inst.of Physics, Zemun, Serbia and Montenegro): Photoacustic spectroscopy of semiconductors under applied electric field

P.Meinlschmidt, F.Schlueter, J.Aderhold (Wilhelm-Klauditz-Institute, Fraunhofer-Institute for Wood Research, Braunschweig, Germany): Thermographic quality monitoring of a continuous laminating process

A.Kapidzic[1], M.D.Dramicanin[1], V.Jokanovic[2] ([1]Inst.of Nuclear Sciences 'Vinca', Belgrade, [2]Inst.of Techn.Sci. of the Serbian Acad. of Sci. & Arts, Belgrade, Serbia and Montenegro):Nonlinear Photothermal spectroscopy of metal surfaces (poster)

L.R. de Freitas1, E.C. da Silva1, A.M.Mansanares1, C.R.M. de Oliveira2, M.C.B. Pimentel2, S.Finco2 (1Gleb Wataghin Physics Inst., Campinas State University, Campinas-SP, Brazil, 2Centro de Pesquisa Renato Archer, Campinas-SP, Brazil): Photothermal reflectance microscopy as a tool for non-destructive evaluation of operating electronic devices

P.V.Astakhov (Gomel Engng. Inst.o.the Ministry for Emergency Situation of the Republic.o.Belarus, Gomel, Belarus): The using of Bessel light beams for the control of thermophysical properties of heterogeneous media by the photodeflection method

7. Heat and mass transfer

N.Celik , H.Eren (Univ.of Firat, Fac.of Engng., Elazig, Turkey) Temperature and velocity field of a rectangular jet

L.Bilir, B.Ozerdem, Z.Ilken (Izmir Inst.of Technology , Mech.Engng. Dept., Urla, Izmir, Turkey): The effect of tube location and ellipticity in plate fin-tube heat exchangers

S.A.M.Said, M.A.Habib, H.M.Badr, S.Anwar (King Fahd University of Petroleum and Minerals, Dhahran, Saudi Arabia): Natural convection inside horizontal channels

A.Midilli[1], E.K.Akpinar[2], Y.Bicer[2] ([1]Nigde Univ., Nigde, [2]Firat Univ., Elazig, Turkey): Energy and exergy analyses of drying of red pepper slices in a convective type dryer

E.K.Akpinar, Y.Bicer (Mech.Engng.Dpt., Firat Univ., Elazig, Turkey): Comparison of single layer drying models for peppermint drying process

A. Al-Sarkhi (The Hashemite Univ., Zarqa, Jordan):Comparison between variable and constant height shrouted fin array subjected to forced convection heat transfer

H.F.Oztop (Dpt.of Mech.Engng., Firat Univ., Elazig, Turkey): Laminar fluid flow and heat transfer in a lid driven cavity with rectangular body inserted

J.-Y. Shin, Y.-S. Son (School of Mech.Engng., Dong-Eui Univ., Busan, Korea): Experiments on the thermal-hydraulic characteristics of a chanel with pin-fin structure

H.Shokouhmand, Y.Morady (Univ.of Tehran, Tehran, Iran): Effect of tube-to-tube conduction on two-dimensional plate-fin and tube heat exchanger performance

K.Kuvvet, T. Yavuz (Karadeniz Technical University, Trabzon, Turkey): Turbulence and heat transfer characteristics in internally finned concentric passage

8. Infrared radiation

A.O.Guimaraes, A.M.Mansanares, E.C. da Silva, A.C.R.N. Barboza, M.-A.De Paoli (UNICAMP, Campinas-SP, Brazil): Thermal properties of polypropylen composites with hollow glass microspheres: a photo-thermal study

J.-L. Tissot, J.-P. Chatard, B.Fieque, S.Tinnes, O.Legras (ULIS-BP21-38113 Veurey-Voroize, France): Medium waveband infra-red amorphous silicon based (320x240 pixels) uncooled microbolometer 2D array for process control applications

9. Thermotechnics

Ch.T'Joen, F.Vanhee, H-J.Steeman, M.DePaepe (Dpt.of .Flow, Heat & Combustion Mechanics,Ghent University, Gent,Belgium):Experimental and numerical investigation on the convection coefficient of a fin-and-tube evaporator with air mal- distribution

N.Brammer, M-A Hessami (Monash Univ., Dpt.of Mech. Engng., Clayton, Victoria, Australia): Contribution of distributed generation:An Australian case study

M-A Hessami (Monash Univ., Dpt. of Mech. Engng., Clayton, Victoria, Australia): Fuel consumption and heat balance calculations for the heating cycle of an industrial kiln

O.Bautista[1], F.Méndez[2] ([1]Inst.of Technology, Monterrey's University, México D.F., [2]Fac.of Engng., UNAM, México D.F., Mexico): Moving sheet with variable thermal conductivity emerging from a slot

J.O.Jaber (The Hashemite Univ., Zarqa, Jordan): Drying-kinetics of two different oil shale samples using thermogravimetric analyzer, conventional oven and direct solar insolation

T.Reményi (Flow-Cont Ltd., Budapest, Hungary)
Thermal mass flow meters

T.Ayhan, H.Al Madani (Univ.of Bahrain, Dept.of Mech.Engng., Isa Town, , Kingdom of Bahrain): Pressure drop characteristics and flow visualization of an array of plates aligned at angels to the flow in rectangular duct

M.S.Valipour (Sharif University of Technology, Tehran, Iran): Mathematical modelling of heat and mass transfer in a moving bed furnace

Y.Kaptan[1], E.Buyruk[1], A.Can[2] ([1]Cumhuriyet Univ., Sivas, Turkey, [2]Trakya Univ., Edirne, Turkey): Numerical investigation of fouling on cross-flow heat exchanger tubes with conjugated heat transfer approach

D.Golbasi[1], E.Buyruk[1], A.Can[2] ([1]Cumhuriyet Univ., Sivas, Turkey, [2]Trakya Univ., Edirne, Turkey): Numerical investigation of double pipe heat exchanger effectiveness depends on different geometry of fouling

Z.Oktay[1], A.Hepbasli[2] (1Balikesir Univ., Engng. Fac., Balikesir, Turkey, 2Univ. of Ontario Inst.of Technology (UOIT), Oshawa, Ontario, Canada): Energy analysis of a coal-fired power plant in Turkey

T.Tokdemir, Z.Oktay (Balikesir Univ., Engng.Fac., Balikesir, Turkey): Energy utilization of a newspaper plant in Turkey

D.Kaya[1], E.Buyruk[1], A.Can[2] ([1]Cumhuriyet Univ., Sivas, Turkey,; [2]Trakya Univ., Edirne, Turkey): Numerical investigation of enhancement of heat transfer for different type of fins placed on a plate

B.Cuhadaroglu (Karadeniz Technical University, Trabzon, Turkey): An experimental study on the influence of hazelnut shells addition to briquette mortar on thermal conductivity

O.Aydin, M.Baki (Karadeniz Technical University, Trabzon, Turkey): An experimental investigation on the temperature separation in a counter-flow Vortex tube

10. Thermodynamics

S.Sieniutycz
(Warsaw Univ.of Technology, Fac.of Chem. & Process Engng., Warsaw, Poland): Work limits in nonlinear systems with radiation

M.Guen (Fac.of Mech. Engng., Univ.of Sci. and Technology of Oran, Oran, Algeria): Thermodynamic model of a diesel engine with direct injection

R.Fatehi, M.H.Saidi (Sharif University of Technology, Tehran, Iran): A multiphase-multicomponent thermodynamic approach to cloud nucleation analysis

B.Ayhan-Sarac[1], T.Bali1, T.Ayhan[2] ([1]Karadeniz Techn. Univ. Trabzon / Surmene, Turkey, [2]Univ.of Bahrain, Dpt.of Mech. Engng. Isa Town, Kingdom of Bahrain): Heat transfer, pressure drop and exergy relationship for tubes with axial swirling-flow promoters

A.Can[1], M.Zivic[2], A.Galovic[3] ([1]Trakya Univ., Edirne, Turkey, [2]Univ. of Osijek, Slavonski Brod, Croatia, [3]Univ.of Zagreb, Zagreb, Croatia): Energy and exergy analysis of the parallel and counter flow heat exchanger using measured data

G.Lebon (Liege University, Liege, Belgium): Thermal transport at nano-scales within extended irreversible thermodynamics

H.Shokouhmand, H.Bahrami (Univ.of Tehran, Tehran, Iran): Effect of diameter of tube, number of turn and filling ratio of working fluid on open loop pulsating heat pipes's performance

A.Akbulut, F.Gulcimen, A.Dikici, E.Turgut (FiratUniversity., Techn. Education Faculty, Elazig, Turkey): Energy and exergy analysis of biogas reaktor which used different organic manure with solar energy heat controlling and phase change material

A.Galovic[2], Z.Virag[2], M.Zivic[1] ([1]Univ.of Osijek, Slavonski Brod, Croatia, [2]Univ.of Zagreb, Zagreb, Croatia): Analysis of local exchanged heat flow rate and lost of available work in parallel and counter flow heat exchangers

A.Hilligweg[1], M-A Hessami [2] ([1]Nuremberg Univ. of Appl. Sci., Nuremberg, Germany, [2]Monash Univ., Dpt.of Mech. Engng., Clayton, Victoria, Australia): Use of process waste heat in thermal refrigeration cycles

11. Engines

M.R.Modarres-Razavi (Ferdowsi Univ.of Mashhad, Mashhad, Iran): Comparison of combustion characteristics between Diesel & Diesel-Gas Engine operation

Z.Sahin, O.Durgun (Karadeniz Techn. Univ., Fac.of Marine Science, Trabzon, Turkey): Theoretical investigation of light fuel fumigation and probable developments in diesel engines

M-A Hessami (Monash Univ., Dpt.of Mech.Engng., Clayton, Victoria, Australia): An experimental study of the exhaust emissions from an compression ignition engine using Diesel and compressed natural gas: the particulate matter and opacity correlation

H.Bayraktar, O.Durgun (Karadeniz Techn.Univ., Fac.of Marine Science, Camburnu-Surmene, Trabzon, Turkey): The effects of using ethanol and gasoline-ethanol blends on flame propagation process in spark-ignition engines

12. Fuel cells

F.A.Coutelieris (National Center for Scientific Research 'Demokritos', Athens, Greece): Analytical solution of the heat transfer problem in hydrogen-fed fuel cells for various flow regimes

H-J.Steeman, M.DePaepe (Dpt.of Flow, Heat & Combustion Mechanics, Ghent University, Gent, Belgium): Molten carbonate fuel cell modell for the commercial flowsheet program 'Aspen Plus'

K.Rezapour, H.R.Niesaz, F.Aminsalehi (Techn. & Engng. Fac., Islamic Azad Univ., Karaj Branch, Karaj, Iran): Application of fuell cell for supplying of district heating and cooling

S.Filatov, G.Kuchinski, B.Bazylev, O.Filatova (Heat & Mass Transfer Inst.of NAoS of Belarus, Minsk, Belarus): Microscale heat transfer in advanced PEM fuel cells

13. Air cooling

Z.Takacs (EGI-Contracting/Engineering Co.Ltd., Budapest, Hungary): Environment protection via exhausting boiler flue gases through natural draught dry cooling towers

H.Shokouhmand, B.Ghaempanah (Univ.of Tehran, Tehran, Iran): Effect of site conditions on the optimized design of the natural draft dry cooling towers

M.Ameri, H.Nabati, A.Keshtgar, M.Nabizadeh, H. Shahbaziyan (Power Plant Engng. Dpt., Power & Water University of Technology, Tehran, Iran): The installation & testing of the fog inlet air cooling system for the Shahid Rajaie combined cycle power plant

H.Shokuhmand, B.Ghaempanah (Univ. of Tehran, Tehran, Iran): Optimization of natural draft dry cooling towers by means of multi-objective genetic algorithm

June 29 - July 1, 2005

32nd ANNUAL MEETING OF THE
AMERICAN ACADEMY OF THERMOLOGY

RECENT ADVANCES IN CLINICAL APPLICATIONS OF INFRARED MEDICAL TECHNOLOGY
"SCIENCE WILL PREVAIL"

Sheraton Baton Rouge Convention Center Hotel
Baton Rouge, Louisiana

Program Committee:
Pierre L. LeRoy, M.D., F.A.C.S., Chairman
Robert L. Elliott, M.D. PhD.
Srini Govindan, M.D.
Gerald Goldberg, M.D.
Timothy D. Conwell, D.C., F.A.C.O.
Philip Hoekstra, PhD.
David Pascoe, PhD.
Jim Walsmith, D.V.M.
Jonathan F. Head, PhD.

PRELIMINARY PROGRAM

Wednesday June 29th

7 p.m. - 8 p.m. REGISTRATION

Presidents Welcome Reception
Sheraton Convention Center

8. p.m.-9 p.m.Special Program Committee Meeting
Drs. R. Elliott and P. L. LeRoy

1. Call to order
2. Final program review
3. Sir William Herschel awards, recognition nominations & notification
4. Issues
5. Session and tract registration by moderators for for CME credit compliance
6. AAT-Board of Examiners;
commentary, Dr. S. Govindan
7.Proceedings committee designate (TBA)-faculty and topics
8. Disclaimer of opinions expressed by faculty
9. In memorium:
10. Next annual meeting - date; location; theme

Thursday June 30th

Program Chairmen
Robert Elliott, M.D., PhD &Pierre L. LeRoy, M.D., F.A.C.S.

8:30 a.m. Welcome Opening Remarks
Robert Elliott, M.D., PhD., President AAT

9:00-10:00 a.m.Plenary Sessions Chairman: Dr. P. L. LeRoy

9:00-9:30 a.m. Speaker: Dr. V. Klemas, Professor, College of Marine Studies, University of Delaware,Director of Remote Sensing: "Terrestrial and Oceanographic Correlation of Infrared Technology with the Biosciences";

9:30-10:30 a.m. Speaker: Dr. James Giordano, "Basic Neuro Anatomy and Physiology of Autonomic and Somatic Nervous Systems and their Pathological Correlates in Thermal Regulation"

Audience participation; questions; answers; commentary.

10:30-11:15 a.m. Coffee Break; Visitor Exhibits
Poster Sessions; Biomedical systems review

11:15 a.m.-12:00 p.m. Speaker - N.N.
Pain Management and Thermology

12:00-1:00 p.m. Lunch and Special Executive Committee Meeting

1:00 p.m. Track Sessions Presentations; Objectives; and Abstract summation for proceedings

1.Breast Thermology - Dr. R. Elliott, Moderator

2.Musculoskeletal - Dr. Tim Conwell, Moderator

3.Neuropathic - Dr. J. Goldberg, Moderator

4.Vascular - Dr. Jonathan Head, Moderator

5.Veterinary (Equine) - Dr. R. Purhoit, Moderator

1. Sophia Wilcox, USDA-ARS, Livestock Behavior Research Unit, "Thermography in Animal Stress Physiolgy Research

3:00 p.m. Coffee Break; Exhibits; Poster Sessions
Biomedical Scientific Demonstrations

3:30 p.m. General Membership Meeting; "The State of the American Academy of Thermology

Plenary Session, "Speaking with One Voice", Discussion of the American Academy of Thermology and Other Thermographic Societies issues

Chairman: Dr. Robert Elliott
Panel: Drs. Hoekstra, Conwell and Goldberg
Audience participation

4:30-5:30 p.m. Key Note Speaker: Dr. Ringermacher - Senior Research Physicist.,The General Electric Global Research Center, Schenectady, New York.
Advanced Overview of Infrared Technology.

6:00 p.m. Informal meetings (optional)

Friday July 1st

8:30-9:00 a.m.Plenary Sessions - Dr. P. L. LeRoy
Dr. Nick Diakides " Historical update of Thermology"

9:00-9:30 a.m. Speaker - Dr. Victor Klemas
The Basic Science of Infrared Physics

9:30-10:15 a.m. Coffee Break; Exhibits;

10:15-11:15 a.m. Speaker - Dr. James Giordano
Advanced Neuro Anatomy and Physiology of the Autonomic and Related Systems

11:15 a.m.-12:00 p.m. Speaker N.N.
Medical and Surgical Applications of Thermology

12:00-1:00 p.m. Lunch Award and recognition presentations - Dr. Robert Elliott, President

1:00-2:00 p.m. Plenary Sessions -
Tutorial workshop and consensus discussion of AAT Guidelines for Indications on Testing and Serial Follow Up Examinations

Chairmen: Drs. Schwartz and Goldberg
Panel: Drs. Herrick, Conwell, Loder, Hoekstra, Diakides.

2:00-3:00 p.m. Thermology examinations

Chairman: Richard Herrick, M.D.

3:00-4:00 p.m. Track Sessions Presentations

1.Breast Thermology - Dr. R. Elliott, Moderator

2.Musculoskeletal - Dr. Tim Conwell, Moderator

3.Neuropathic - Dr. J. Goldberg, Moderator

4.Vascular - Dr. Jonathan Head, Moderator

5.Veterinary (Equine) - Dr. R. Purhoit, Moderator

4:00-5:00 p.m.
Special Open Meeting - Biomedical Engineers
Dr. Pierre L. LeRoy, Moderator

Agema
Angioscan
Dorex
Flir
Mitsubishi

5:00 p.m. Adjournment

6:00 p.m. Informal meetings (optional)

June 29- July 1, 2005

6th Course on the Theory and Practice of Infra Red Thermal Imaging in Medicine
at the University of Glamorgan,Pontypridd CF371DL, United Kingdom

Speakers include ·
Prof. K. Ammer, MD PhD
(Ludwig Boltzmann Inst. f. Physik. Diagnostics, Vienna)
Prof. F.J. Ring, DSc FIPEM (University of Glamorgan)
Dr. P. Plassmann PhD (University of Glamorgan)
Dr. R. Thomas (University of Swansea)

PROGRAMME:

Day 1 (Wednesday, 29June)
Theoretical and Historical Basis of Thermal Imaging in Medicine ·
11.00-12.15 Registration in the Foyer of 'J-Block'
(also known as 'Tâf' Building) next to 'Bytes' cafeteria ·
12.30-13.30 Lunch
13.30-14.30 History and development of IR imaging (FR)
14.30-14.40 Physical principles of heat transfer (FR)
14.40-15.20 Break and
check-in to University accomodation
15.20-16.15 Principles of thermal physiology 1 (KA)
16.15-16.30 Film (cold and warm exposure)
6.30-17.20 Principles of Thermal Physiology 2 (KA)

Day 2 (Thursday, 30 June):
Clinical Applications of Thermal Imaging
09.00-09.45 Standard protocols for image capture (FR)
09.45-10.15 Provocation tests 1 (FR)
10.15-10.45 Provocation tests 2 (KA)
10.45-11.15 Break
11.15-12.15 Detector and camera systems (RT)
12.15-12.45 CTHERM software introduction (PP)
13.00-14.15 Lunch

14.15 15.15 Parallel sessions, two groups
: o Film (Living body- thermoregulation)
o Practical Lab image capture ·
15.15-15.30 Break · 1
5.30-16.30 Causes of temperature increase (KA)
16.30-17.15 Causes of temperature decrease (KA)
19:00 Course Dinner

Day 3 (Friday, 1July)
Practical session capturing and analysing images
09.15-09.50 Producing a thermographic report (KA)
09.50-10.10 Discussion
10.10-10.25 Break
10.30-12.30 Practical Session:
oUsing CTHERM software on images taken on day 2 (PP)
oGuided image analysis (FR/KA) ·
12.30-12.45 Archive CD of thermographic papers: installation / demo (PP)
13.00-14.00 Lunch - Gallery Suite ("Conservatory Restaurant")
14.00-15.00 Future developments of thermal imaging in medicine
o 1. Image databases and image exchange (FR)
o 2. Integration into hospital DICOM systems (FR)
o 3. Medical Education, Journals and conferences (KA)
15.00 Close

Registration Fee £350.
Cheques should be made payable to The University of Glamorgan. Prior reservation is essential. Booking form Website: www.medimaging.org

The fee includes:
lunch and refreshment breaks,
book on thermal imaging in medicine
CD of archived IR imaging in medicine publications.

Accommodation: As the course is being held during the academic term every effort will be made to find campus accommodation for those participants who need to stay at the University.Check-in after 14:00. If you plan to arrive late in the evening, please let us know.There are also some Hotels and B&Bs nearby (contact details on request, see booking form) for those with a car.

Certificate: The course is recognised by the University of Glamorgan and certificates will be issued to all who complete the course.

Information:
Prof.Francis Ring, Medical Imaging Research Group
School of Computing , University of Glamorgan,
Pontypridd CF371DL, UK, email: efring@glam.ac.uk.

Website: www.medimaging.org

October 6-8, 2005
Annual Conference of the Romanian Society of Thermography in Campina, Romania

Theme: Imaging osteo-articular pathologies

Deadline for abstract submission: 15th May 2005

(Please email your abstracts to office@srt.ro)

Registration deadline: 1st September 2005

Information:

Dr Tiu Calin

Tel/fax +40 244 373 108

Email: office@srt.ro)

Website: srt.r5

October 22, 2005
18th Thermological Symposiumof the Austrian Society of Thermology and the Ludwig Boltzmann Research Institute for Physical Diagnostics

Venue: SAS Radisson Hotel, Vienna

Main theme. Advances in Thermal Imaging and Temperature Related Therapy

Deadline for abstracts: September 15, 2005

Information: Prof Dr Kurt Ammer PhD

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