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Abstracts

THERMOGRAPHIC STUDY OF TOPICAL COOLING AGENTS FOR THE SKIN

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Simple treatments based on the application of cold for localised minor injuries or pain, have been in use for many years. The commonly used technique is the application of crushed ice packs. This is more usually applied under supervision in a hospital clinic or physiotherapy department. Ice packs rapidly apply low temperatures to the skin, and cooling is accelerated if the ice is contained in a wet towel. One disadvantage is that for self-treatment it is less convenient to apply to some areas of the trunk than the extremities.

In recent years chemical products have been introduced for home or outpatient use. They are safe, inexpensive, and suitable for self-application. They may take the form of encapsulated gels, which are refrigerated before use, or a chemical reaction may be started by breaking a seal. In addition a gel can be applied to the skin, or an aerosol pack of coolants can be used.

In this study we report a comparison of ice packs applied to the lumbar spine of normal subjects for 10 minutes compared to a cold gel (Deep Freeze) applied to the same area on another day for 60 minutes.

The subjects were examined in the prone position, lying on a couch in a temperature controlled room at 22C. After 15 mins stabilisation thermograms were recorded until no further temperature changes were evident. The 10x10cm Ice pack or gel was applied to the skin at the L4 level. The Thermographic Camera Flir SC500 was stand mounted above the patient in a vertical position. Automatic software CTHERM) was used for image capture at 3 minute intervals for a further 60 minutes. Subjective assessments were also recorded from each volunteer through the examination. Results showed that although a lower skin temperature was reached with ice (mean fall of 7C) the temperature recovered quickly within 20 minutes. The gel applied to a 10x10 cm area of the lumbar region showed a more gradual fall in temperature mean approx 3.5C but this persisted for most of the 60minute application. After 50 minutes there was a slow rise in temperature towards baseline.

In a second in-vitro experiment three commercial aerosol coolants for topical skin use were sprayed onto 3 equal sized aluminium plates of 20x20cms. One surface was painted with matt black paint to achieve an emissivity of 0.95. This surface was imaged by automatic software at 1 minute intervals for 20 minutes. The unpainted surfaces were simultaneously sprayed with an equal does of the aerosol coolants. The cooling and rewarming of the plates was assessed by plotting the mean and standard deviation of temperature from each plate. The experiment was repeated and the order changed to obtain a mean of five such experiments for each product. The results showed that in this simple physical test the cooling effect of the three compounds on metal were not equal. However two of the products also contain other agents for pain relief. These finding will be compared to an in-vivo comparison using normal subjects.

This study demonstrates that quantitative thermal imaging is a simple and objective tool for the evaluation of such topical cooling treatments. It is however important to assess the emissivity of any applied substance which could have a significant effect on temperature measurement by remote sensing.

HOT AND COLD

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A documentary scientific film on thermal physiology of the human body recorded at Bath and in The French Alps for British Television. (1980). This film traces the human body changes through a day in the life of two young skiers on holiday. There are many animated sequences to explain body temperature regulation, and the effects of a warm and cold environment on the body. Thermal images were recorded with an early real time thermal camera. The resolution by modern standards is poor but the film maker has effectively mixed from visible to infra red to demonstrate the skin temperature responses to the temperature changes from exposure in the snow to a sauna bath at the end of the day.

STANDARDISATION OF THE TECHNIQUE OF THERMAL IMAGING IN MEDICINE: ISSUES FOR THE CREATION OF A REFERENCE ATLAS OF NORMAL THERMOGRAMS.

Report of the Anglo-Polish Research Group 2004.

Prof. A.Jung, Prof. B Wiecek, Prof. E.F.J.Ring, Prof. K Ammer, Dr. P Plassmann, Dr C Jones, P Murawski, T. Buczkowska-Murawska, S. Zwolenik, Prof.B.F.Jones.

This group has been preparing for the creation of a digital thermal image atlas of the human body. The aim is to establish a series of standardised thermograms recorded from normal subjects under identical conditions. During the past three years eight areas of the clinical procedure have been identified where variation and unreliable results can occur. Each of these areas has been investigated and solutions and recommended protocols have been developed.

1. Securing the full cooperation of the patient and referring physician. This is largely a question of supplying the correct information, to ensure that full cooperation during the examination, including the preparation time will be achieved.

2. The thermal imaging system, its reliability, calibration and stability.

3. Image capture. The use of standard positions and views of each area of the patient fitted to electronic masks provided by the software is a major step in standardisation.

4. Image analysis, the placing of shape and size of regions of interest. These have been defined to anatomical landmarks and may be incorporated into the software.

5. The storage and retrieval of thermograms, maintaining all data relating to the patient and the images that are essential for accurate repeat investigations.

6. The ability to transfer images electronically on and off line with full quantitative parameters intact.

7. Image presentation, ability to compare new images with reference data on screen, and to be clinically unambiguous.

8. To address the lack of knowledge and training issues relating to the clinical performance of the technique. The availability of archive and teaching materials, courses and education has been addressed.

STATISTICAL ANALYSIS OF THE THERMOGRAMS IN MEDICAL DIAGNOSIS

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The medical thermograms are very often analyzed as a beautiful pseudo-colour picture.
It means any one or only some easier statistical analysis is made. Those statistical parameters like a mean, the standard deviation and the median value of a temperature is computed and used for comparison. This method helps us to "see" difference between regions but could not help us to correlate it with a correct medical diagnosis. This situation could be dramatically changed when we use more advanced method for thermal signal analysis.

In our work we present the other possibilities of thermograms comparison, which can be used in medical applications. It is suggested thats new parameters connected with a neural networks application help us to allocate correctly to the classification groups (diseased and healthy).

INFRARED THERMOGRAPHIC ANALYSIS OF TEMPERATURE DISTRIBUTION ON THE SURFACE OF HUMAN TEETH DURING ND:YAG LASER IRRADIATION IN DEPENDENCE ON THE POWER AND REPETITION RATE OF THE LASER - IN VITRO STUDY

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Aim: This study was designed to use thermovisive method of temperature measurement to analyze the in vitro tooth surface temperature changes during Nd:YAG laser irradiation of human teeth with different power and repetition rate settings.

Methodology: A model was designed to allow temperature measurement with an

Infrared thermal imaging system. Upper extracted incisor was cut along its axis and placed in the dish with saline, in such a way that only a root was dipped. The external surface of incisor was coronally irradiated with the Nd:YAG laser for 30 s. The energy were varies from 1W to 5Wwith a repetition rate of 20 pps to 30 pps. Thermal change at the time of laser irradiation was measured coronally by thermovision. Measurements were repeated without saline in the dish.

Results: Our results revealed, that irradiation with Nd:YAG laser at 1 - 5 W applied on the external surface of human teeth elicited much higher temperature (even at above 200 degrees C at a power of 5W) when the tooth wasn't embedded in saline.

Conclusions: The Nd:YAG laser irradiation, applied on the external surface of human teeth may result in high temperatures in the root canal wall. Infrared thermography is a useful device for mapping patterns of temperature change over a large area.

HYPOTHERMIC CHANGES OF SKIN TEMPERATURE

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Thermal imaging is a technique capable to map the temperature distribution on the human skin. In healthy subjects skin temperature is highly symmetrically distributed related to a symmetry axis situated in the median plane of the human body. In the extremities, higher temperatures are normally seen at the proximal end of the limb than on the tips of fingers or toes. Any disturbance of these normal temperature pattern may be detected either as hyperthermic or hypothermic area.

This paper will give examples of hypothermic skin changes, which may be caused by decreased blood flow, loss of muscle contraction, sympathetic hyperactivity induced by partial nerve lesion, lymphedema or artefacts due to the environment. Typical findings from patients with obstructive angiopathy . Raynaud`s phenomenon, motor deficit due plexus paresis, poliomyelitis, herpes zoster, radiculopathy, peroneal palsy and decreased range of motion induced by arthritis or arthodesis will be presented . The thermographic changes of common nerve entrapment syndromes such as carpal tunnel syndrome, thoracic outlet syndrome and ulnar nerve entrapment will be discussed. Cases of reflex dystrophy, thermal images from patients suffering from lymphedema and some artefacts causing hyperthermic changes of the skin temperature will close this lecture.

TEMPERATURE EFFECTS OF THERMOTHERAPY DETERMINED BY INFRARED MEASUREMENTS

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This paper reviews the results of studies, in which the effects of heat or cold treatment were evaluated by infrared technology for temperature measurements. The advantages of infrared based temperature determination is measurement without contact and the ability to measure the surface temperature of an area simultaneously using either a scanning mechanism or a focal plane array. The limitation of this technique is the dependence of the results on both spectral and directional emissivity and the possible filtering effect of water on the surface of the object to be measured. Applying infrared measurements on living beings with a working temperature regulation system, generate further problems when temperature measurements need to be interpreted.

Infrared temperature measurements was used after application of various forms of cryotherapy such as cold air, nitrogen-air mixture, ice cubes or cold packs in both animals and humans. The effects of balneotherapy on skin temperature was investigated after thermo-neutral, hypo- and hyperthermic baths. The temperature course of hot packs used for medical treatment was studied and the influence of heat packs on the skin temperature of the human back has been shown. The depth of warming after application of ultrasound of different frequencies was clearly demonstrated by thermal imaging in a recent study. Older studies have used radiometers for measuring skin temperature after short wave application.

The change of skin temperature after application of various forms of heat and cold therapy is dependent on the duration of the treatment, the physical properties of the therapeutic agent, the body region treated and the thermal balance of the treated subject. Infrared technologies can reliable determine the temperature course of the treated surface.

PROVOCATION TESTS WITH THERMAL IMAGING

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The majority of applications of thermal imaging In mediclne, depend on recording images of skin temperature after a period of preparation at a controlled temperature. If the subject is sufering from an inflammatory disease, lower room temperatures e.g.20°C are used. Other applications, which may be dependent on vasomotor activity, are recorded at 22-24°C. This is to maintain the vascular system in equilibrium, and avoid undue vasoconstriction.

However, there are situations where more information can be gained by the application of a physiological challenge. Thermal imaging can then be used to objectively record the response to challenge, which can be affected by some clinical conditions.

A challenge to the skin may take the form of a chemical, either topical or oral, a thermal (application of hot or cold) or mechanical.

An example of a chemical challenge may be the use of a skin test for allergy. Some agents such as nicotinic acid can be applied to the skin to assess the acute inftammatory response.

Thermal tests are more widely used for the evaluation of Raynaud‘s phenomenon.

The most widely accepted method is to record thermograms of the dorsal hand, before and at intervals after short immersion in water. Different authors have published their method where the water temperature is around 20°C or wider for 1 minute. In all cases the hands are kept dry by the use of plastic gloves. Imaging is then performed to assess recovery over 10-15 minutes.

In vibration injury to the hands, vasoconstriction by cold water immersion may be found, but the application of vibrating equipment to the fingers can be a sensitive method for detecting this form of neuro-vasacular injury.

A method, which proves to be reliable, is to use a water bath at 20°C, immerse the hands to the wrists for 1 minute, then after removal of the gloves, record thermograms at 10 and 15 minutes. By measuring the mean temperature of the fingers and the dorsal hand (MCP‘s to wrist area) before and after stress a good indicator of recovery can be calculated. Some normal subjects produce reactive hyperaemia, others fall to recover baseline temperatures, especially in Raynaud‘s phenomenon.

DERMATOLOGICAL APPLICATIONS OF THERMOGRAPHY

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Generally, pathological processes based on microcirculation changes or inflammation development can be evaluated using thermographic protocols. As thermography is a noninvasive, non-contact, virtually devoid of side-effects method, it gains more and more applications in the clinical settings.

5km is the most easily accessible of all the Organs, thus is seems perfectly justifiable that thermography could be wider and wider used just also in dermatology. As many dermatological conditions either present systemic features or their liirther therapy requires different specific procedures, thus many specialists are generally involved in the management of a single patient. So, dermatological applications of thermography could overlap with oncology, rheumatology, surgery, alergology and others.

Thermography gains its clinical applications in diagnosis andlor differential diagnosis of many pathological conditions, evaluation of disease severity, management planning, monitoring of therapeutic effects including recurrence ofthe disease and metastases demonstration.

Thermography has been implemented in diagnosis ofboth vascular and pigmented skin lesions including angiomas, melanocytic naevi and malignant melanomas. This method is used in extensiveness evaluation ofchilblains, burns, ulcers ofvarious origins and their healing. Thermographic procedures are applied for the evaluation of psoriatic plaques severity, psoriatic arthritis, morphea - including plaque and linear forms, venous insufficiency, Raynaud‘s phenomenon in the development towards systemic sclerosis or even efficacy of hair regrowth in alopecia patients. They are also employed in monitoring of antiinflammatory treatment, cryotherapy, chemotherapy, engraftment or rejection of skin transplants and skin prick tests or patch tests evaluation.

Despite, quite an extensive literature data on the different dermatological applications of thermography, one has to bear in mmd that proper standardization protocols are absolutely prerequisite for this technique to become a screening and reliable one in dermatological practlce.

THERMOGRAPHIC DATA ANALYSIS OF PSORIATIC SKIN LESIONS

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Psoriasis is a chronic, non-infectious inflammatory disorder affecting up to 2% ofthe population all over the word. lt is characterized by well-demarcated erythematous plaques covered by silvery scales. Inherited polygenic factors predispose to the development ofthis disease. Changes of dermal microvasculature, inflammation and epidermal hyperproliferation are well-recognized features of psoriatic plaques.

The purpose of our study was to perform thermographic analysis of psoriatic plaques presenting different degree of hyperkeratosis. Series of psoriatic lesions of different duration and localization were evaluated as for their induration, erythema and desquamation and were subsequently correlated with temperature measurements. The thermocamera INFRAMETRICS 760 was used in our investigation. Temperature resolution was 0. 1°C. The examined patients were prepared undressed for 20 min in a specially designed room before each thermographic examination.

Some correlation between thickness ofpsoriatic plaques and temperature measurements was observed.

However, despite widely accepted knowledge that thermography has quite a few invaluable advantages such as non-invasiveness and lack of side-effects, many properly designed, based on large number of cases studies are required in order to implement this technique as a prognostic tool ofpsoriatic plaque severity evaluation.

INFRARED IN NEWBORN TEMPERATURE CONTFORT EVALUATION

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The specific solicitude to assure thermal comfort for a newborn is one of issues in neonatal health care. This highly important problem is based on:

1.The literature has shown increased mortality in cooled newborns

2.the influence ofhypothermia on the lenght of hospital stay - hypothermia prolongs hospital stay and increases treatment costs

3.the direct influence on medical treatment — hypothermia makes the effective care impossible int modern NICU's .

The thermal comfort is connected with the idea of neutral environment temperature — that is the temperature, at which a newborn does not lose ort gain heat and at which oxygen consumption is minimal.

Some doubts still exist, what is the optimal temperature of extremely bw birth weight newborn. Tables for optimal environment temperature warmth are at least 11 years old.

Abdominal skin and toe temperatures were measured, representing of central and peripheral temperatures. Temperature comfort is characterized by the level of three recorded temperatures: Core temperature >36°C, peripheral temperature >35°C, periphcral minus core tempcrature < 2°C. Abnormal temperature event is defined as the occasion where one or more than one of these variables is outside the normal range.

The aim of a study is the evaluation of infrared thermal imaging for the assessment of temperature comfort in newborns. 84 newborns with gestation age 25 —40 Hbd were examined. Body weight was between 750 and 3350g, 40 of them were boys, 44 girls. Babies were allocated into groups depending on gestation age and body weight.

The examination was performcd using ThermaCam PM5 95. The temperatures of forehead, abdominal skin and toe temperatures, differences between forehead and toe temperature and abdominal skin and toe temperature were analyzed.

Differences between temperature measured by the infrared camera and standard temperature measurements (axillary, rectal and skin temperature measured by thermocouple) were analysed..

Temperature obtained from standard procedures were different from temperatures measured by infrared. Optimal environmental temperatures taken from tables and controlled by infrared permitted the correction of the incubator temperature in almost half of the babies.

Conclusions: Temperature comfort evaluation at babies using infrared is simple, quick and usefiul method of monitoring.

NEURAL NETWORK IN CLASSIFICATION OF BREAST THERMAL IMAGES

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An attempt was made to develop an automatic technique for the classification of healthy and malignant breast thermograms. 8 cases of healthy and 8 malignant cases were examined. Two infrared images were recorded of each breast: lateral and anterior views, resulting in a total 32 images for the database of this classification.

For each image 284 numerical features were defined.

First order histogram based features;

Gradient matrix based features;

Run length matrix based features;

Co-occurrence matrix based features calculated for matrices constructed for five distances between images pixels, and for fourth direction;

Wavelet transfomi based features.

From these features ten with highest discriminative power were selected. The selection of features-was tested, based on value of Fisher coefficient F and combined probability of classification error and average correlation between features (POE+ACC). The chosen features were used to classify healthy and malignant cases with two classifiers: the nearest neighbour classification test (l-NN) and artificial neural network (ANN).

When features were selected with POE+ACC methods neural network, all images were correctly classified..

			Healthy		Malignant	
View			Anterior	Lateral	Anterior	Lateral
Images			8	8	8	8
Classification of Errors	F	1-NN	2	0	3	0
		ANN	0	0	1	0
	POE+ACC	1-NN	3	0	2	0
		ANN	0	1	1	0

APPLICATION OF THERMOGRAPHY IN THE DIAGNOSIS OF EYELID MELANOMA INFILTRATING THE CHIN SKIN - A CASE REPORT

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Hyperthermic foci of malignant skin melanoma were described for the very first time by Brasfield in 1964. Further numerous studies on thermographic diagnosis oft that skin malignancy were performed. The results oft the studies report the applicability of thermovision in diagnoses of malignantskin melanoma. We present a case of melanoma of the upper right eyelid in patient, aged 52. Since the seventh year of life the patient had a dark-brown, pigmented lesion within the upper eyelid of the right eye. Three months before the referral, the lesion started to change pigmentation and dimensions. Physical examination revealed a tumor that obstructed the right orbital entrance. Laboratory findings, chest X-ray and abdominal ultrasound were normal. Computed tomography revealed the presence of a hyperdense tumor, 39 X 44 mm in diameter, infiltrating both the surface ofthe eyeball, the eyeball itself, and the orbital muscles. Also a pathological infiltration of the optic nerve has been noted. MRI studies revealed also infiltration of the soft tissues of the upper-right area of the nose. The histopathologieal studies confirmed the diagnosis of malignant melanoma in the tumor specimens. The thermographic examination using ThermaCAMTM SC500 camera revealed thermal asymmetry of the face with a focal hyperthermia located in the right cheek and chin. The histopathological examination of the patient's chin skin specimen, sectioned from the affected hyperthermic area seen in the thermographic studies, confirmed the presence of disseminated malignant melanoma cells. Due to the advanced stage of the cancer surgery was not applied. The case is presented due to the rare localization of the melanoma within the eyelid and the confirmation of local hyperthermia as malignant metastatic lesions to the skin ofthe patient's chin.

COMPARISON OF THE LAND FTI MV AND THE FLIR SC 500 THERMAL IMAGING CAMERA

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Two thermal imaging systems one radiometric and one low cost focal plane array (FPA) camera have been compared under labo-

ratory conditions. The FPA of the Land has half the resolution of the Flir camera (320 x 240).

Both systems were connected to dedicated PC's. The Flir system was connected to a workstation running CTHERM software, the Land System was connected to a PC running Land software.

The Flir SC 500 relies on internal calibration and calibration data contained in the Ienses to provide accurate temperature measurement. In contrast the Land FTI Mv uses two external heat sources for regular recalibration,

A number of image attributes were tested including; noise and uniformity, spatial resolution, and stabiiity. The cheaper Land camera performed well in comparison to the Flir eamera in all tests apart fiom the Spatial Resolution test. Using a heated bar chart the Flir eamera resolved to better than l mm whereas the Land eamera under the same conditions resolved to 3mm. Due to its poor performance in the stability test the Flir camera was returned to the manufacturer where a fault was diagnosed. The Flir camera showed significant improvement in stability following repair and recalibration.

These results show that the low cost Land FTI Mv camera with external calibration can produce stable images suitable for medical applieations. The results also highlight the need for regular monitoring of camera performance.

THERMOGRAPHIC DIAGNOSIS OF PERIODONTAL AREA IN 16-17 YEARS OLD HEALTHY ADOLESCENTS

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Thermographic methods have been used in dentistry for diagnostics and for assessment of the effects of treatment of soft tissues (periodontum), for assessment of the effects of endodontic treatment, in implantology, for assessment of the effect of laser treatment on dental pulp and in assessment of reactivity of periodontum vessels in IDDM sufferers.

The aim of the study was to propose a thermographical model (reference standard) and compare the results of the clinical and thermographical assessment of the periodontal tissues in healthy adolescents.

The subjects ware 18 healthy adolescents, 16-17 years old, whose family members were free from periodontal diseases, did not experience bleeding on teeth brushing and were in generatly good health. The level of the oral cavity hygiene was described with the help of plaque index PI-I after Silness & Löe. The periodontal status was described with the help of Gl after Silness & Löe and SBI after Mühlemann & Son.

The thermographic study was performed with an AGA Thermovision System 680 under standard conditions for thermo graphical analysis.

The thermographical analysis revealed that the periodontal tissues of all subjects were free from periodontal diseases.

The clinical and thermographical analysis was performed for the periodontum in the neighbourhood of the upper jaw incisors. The reactivity of the blood vessels was determined on cooling. The thermographic measurements ware made prior to the cooling (T0) and 1 (T1),2 (T2),3 (T3), and 4 (T4) minutes after cooling with cold water of a constant temperature (1°C). The minimum, maximum and mean weighted temperatures ware calculated separately for the left and right hand side of the periodontum.

The mean weighted temperatures of periodontal tissues in healthy adolescents were: T0 = 32.7°C, T1 = 27.6 °C, T2 = 27.9°C, T3= 28.5°C, T4 = 28.9°C

The model values of the temperatures and the corresponding thermographic images obtained from these people can be used in further studies as reference standards.