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Thermal Imaging Before and After Physical Exercises in Children with Orthostatic Disorders of the Cardiovascular System

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Summary

Orthostatic disorders of the cardiovascular system in children are frequently caused by transient disturbances of resistive and venous blood vessels.The purpose of this work was to estimate the potential role of thermography in children with orthostatic disorders of the cardiovascular system . The analysis was carried out in 30 children with orthostatic disorders. The control group consisted of aged matched healthy children.

The new generation Inframetrics 760 thermographic camera was used in this study. Every child with orthostatic disorders was subjected to physical training for a period of 1 year to improve cardiovascular reactions. Thermal imaging was repeated after the period with exercises. These studies confirmed differences in temperature distribution in children with orthostatic cardiovascular disorders compared to healthy children used as controls. Both the clinical symptomsof the orthostatic disorders and the temperature changes disappeared after physical exercises. Thermal imaging is a new, non-invasive method for examination of the cardiovascular system, which has been shown to be useful for the diagnosis of orthostatic disorders in children.

Key words: thermography, orthostatic disorders, passive orthostatic test, physical exercises

Infrarotthermographie vor und nach körperlichem Training von Kindern mit orthostatischen Kreislaufbeschwerden

Orthostatische Kreislaufbeschwerden von Kindern sind oft durch eine vorübergehende Störung der arteriellen und der venösen Gefäße verursacht. Das Ziel dieser Arbeit war es, die potentiale Bedeutung der Thermographie für Kinder mit orthostatischen Beschwerden einzuschätzen. Diese Analyse wurde an 30 Kindern mit orthostischen Kreislaufbeschwerden durchgeführt. Eine Gruppe gesunder Kinder gleichen Alters dienten als Kontrollen.

Eine Inframetrics 760, einVertreter der neuen Generation von Infrarot-Kameras, wurde in dieser Studie eingesetzt.Jedes Kind mit orthostatischen Beschwerden wurde ein Jahr lang einem physischen Training zugesführt, um die kardiovaskuläre Leistung zu berbesseren. Nach dieser Trainingsperiode wurden die Wärmebildaufnahmen wiederholt. Die Studie bestätigte unterschiedliche Temperaturverteilungen bei Kindern mit orthostatischen Beschwerden und gesunden Kindern, die als Kontrollen dienten. Sowohl die klinischen Zeichen als auch die Temperaturveränderungen waren nach der Trainingsperuiode nicht mehr nachweisbar. Die Wärmebilduntersuchung ist eine neuartige Methode zur Untersuchung des Herz-Kreislaufsystems , das sich bei der Diagnose von orthostatischen Beschwerden bei Kindern als nützlich erwiesen hat.

Schlüsselwörter: Thermographie, orthostatische Störung, passiver Orthostase-Test, physisches Training

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Introduction

Orthostatic disorders of the cardiovascular system in children, especially during puberty, are often caused by transient functional disorders of the autonomous nervous system. This leads to a decrease in venous blood flow to the heart and a decrease of the ejection volume and cardiac output. These alterations also affect the vascular balance and the state that is referred to as excessive circulatory centralization (3, 5).

Irregular vascular reactions are conditioned by neurological influences that involve the cholinergic system (4, 5, 19).

Orthostatic disorders manifest themselves by feeling faint, a pre-fainting stage or by actually fainting. These result from an anoxaemia of the central nervous system. The swoon appears mainly during changes of body position from horizontal to vertical and are due to a decrease of artery blood pressure and brain hypoxia (9).

Children with orthostatic disorders are usually exempted from physical education classes. However, motor activity is essential in orthostati on a tilt-table at angle 45°, and is an important method for the assessment of orthostatic regulation. It is a very sensitive method: it can detect orthostatic disorders even in those cases where the result of the active orthostatic test was negative (8).

Among the new diagnostic methods are the USG-Doppler evaluation of blood flow in the common carotid artery and oc disorder prevention. Hypocinetics can lead to intensification of orthostatic disorders.

One principal method for the effective evaluation of neurological regulation of the circulatory system is the orthostatic test . The test is carried out for a period of 10 minutes in an upright position by measuring systolic and diastolic blood pressure and simultaneously evaluation of the heart rate frequency and changes in the ECG (17, 20, 21).

Other methods are also used for the evaluation of vascular control mechanisms, e.g. the hyperventilation test, the Valsalva test, the Hines test and the arithmetical test (3, 4, 5, 18).

The passive orthostatic test is performedther non - invasive methods such as capillaroscopy, ultrasonography and more recently thermography (2, 6, 7, 10, 11, 13, 16, 25).

Thermal imaging is a new research method based on remote and contact free evaluation of temperature distribution on the body surface, measuring the thermal infrared radiation. Thermal images can be related to localised functional changes in blood vessels of the skin. Thermograms or thermal maps are very helpful in locating inflammation regions, vasomotor disorders, and – in general – in evaluating the metabolic activity of a tissue. Thermography can be used to evaluate blood flow disturbances (1, 2, 10, 14, 15).

Infrared camera and image processing

An infrared camera and computer system with dedicated software for medical applications were used in the investigations. The system captures thermal and visual images in parallel, and in real-time into the operational memory of a computer. The interface used was a Peripheral Component Interconnect (PCI) plug-in card offering high performance and 32-bit data transfer. An optional burst mode provided accelerated throughput of data across the bus of 132 MB/s. There are systems available for thermal and optical image processing, but most work separately for each channel, often offline, without powerful tools for processing thermal and visual images in parallel. The system presented in this work is one of the first providing enough data transfer throughput to capture and process images in real-time(22, 24).

Software for processing thermal and video images and their sequences was written on a Delphi and C++ language platform as a 32-bit application. It is Windows Millenium and Win 2000 compatible. This software is dedicated for thermal, visual image processing in parallel. There are a number of other useful functions in this software.

One of the very advanced functions provides the ability of directional emissivity correction. This algorithm uses full information about 3D shape of the observed object computed on the base of pictures taken from 2 or more CCD cameras (23, 24). It allows computing the distance between camera and the object in order to measure temperature more precisely.

Objective

The objective of the study was to evaluate the value of infra red thermal imaging for diagnosis of orthostatic disorders of the cardiovascular system in children. The study was focused on the upper regions of the body, especially the head in children with orthostatic disorders before and after the supervised physical exercises.

Material and Methods

The subjects were 30 children (19 girls and 11 boys) aged 11 – 18, with orthostatic cardiovascular disorders. The control group were asymptomatic children at the same age.

The most common complaint – in both girls and boys – was vertigo, and rarely fainting attacks, which appeared on sudden change of body position from horizontal to vertical or while standing for a long time.

In each case an active orthostatic test was made. A positive result qualified for the examination by thermal imaging.

The measurement of temperature changes of the frontal region were made by a new generation thermal camera Inframetrics 760, initially in a horizontal position each 10 seconds for 1 minute, then each 10 seconds for 10 minutes during a passive orthostatic test on a tilt-table at angle 45 degrees.

In the first, third, fifth, seventh and tenth minute of the test the heart rate and blood pressure were measured on the left forearm, by Korotkov's method.

Each child with an orthostatic disorder underwent supervised physical exercises for a period of 12 months (Fig 1). These were the exercises of the upper and lower extremities, the neck and the trunk. The main focus was given to respiratory and relaxation exercises. The work load of the exercises was low, and the speed was slow, with a tendency to change the body positions often. The exercises were dynamic in nature, with gradual increase of the exertion. After a period of 12 months all tests performed at baseline were repeated.

Results

Before Exercise

The temperature parameters of the forehead region in children without orthostatic disorders did not change in subsequent minutes of the test and were not greater than 0,3°C (Fig. 2). In these children the measurements of heart rate and blood pressure did not differ significantly in the subsequent minutes of the test.

The images acquired after rapid data processing were very similar in subsequent images (Fig. 3).

Before physical exercises the temperature of the frontal region differed significantly from controls by more than 0,7°C (Fig. 4) In children with orthostatic disorders. These children showed also increased heart rates and decrease of arterial blood pressure by 20%, comparing to the baseline values.

These differences in temperature are visible on thermal images (Fig. 5).

The study has shown that in children with high grade orthostatic disorders the temperature changes were more significant – up to 1°C and more. (Fig. 6).

In two cases a significant drop of frontal region temperature was followed by decrease of blood

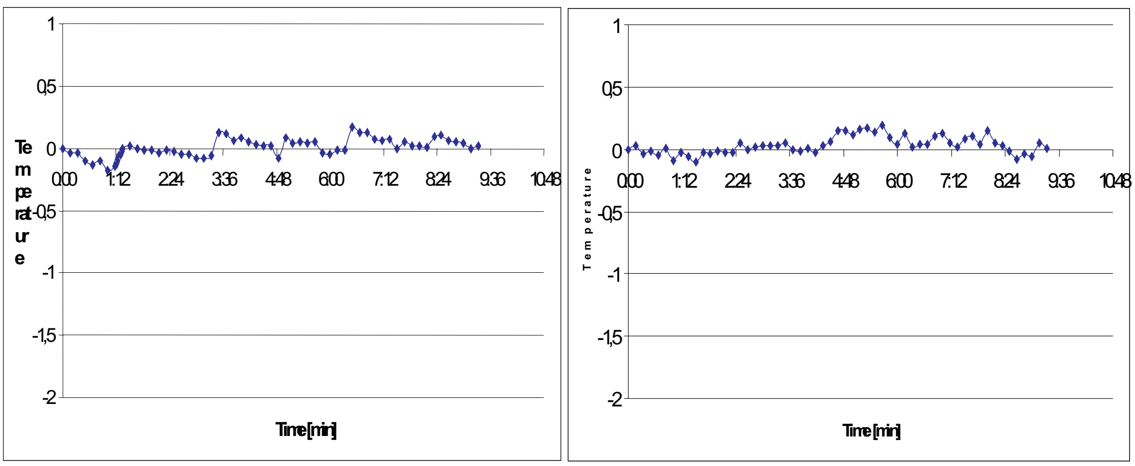
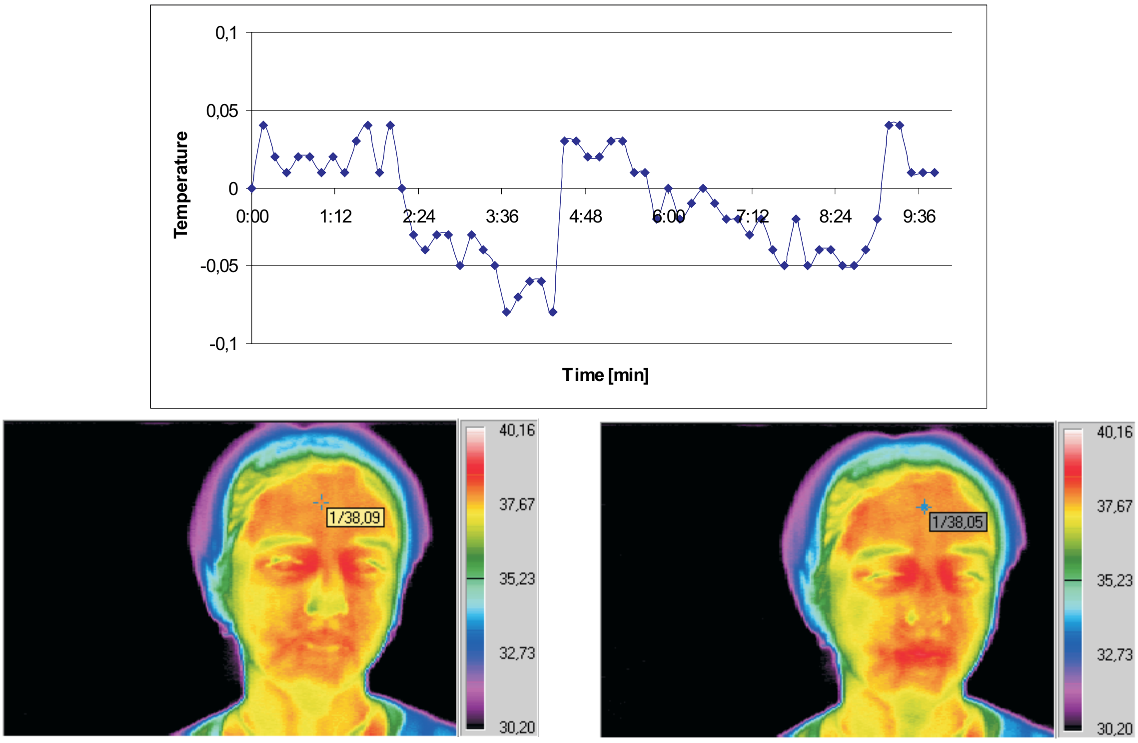


Figure 1
Record of relative temperature distribution in the patients aged 16 (left) and aged 13 (right) without orthostatic disturbances during tilt-test



Before test
10 minutes later

Figure 2

Record of relative temperature distribution and images of the patient without orthostatic disturbances during tilt-test

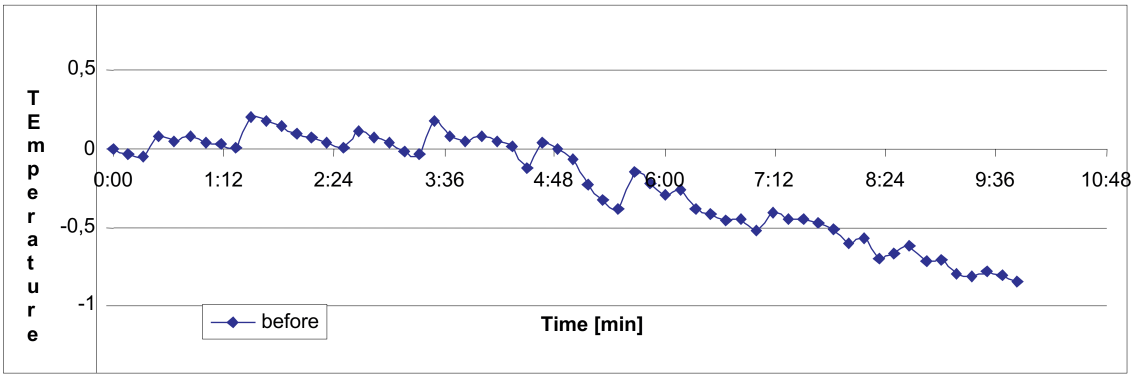
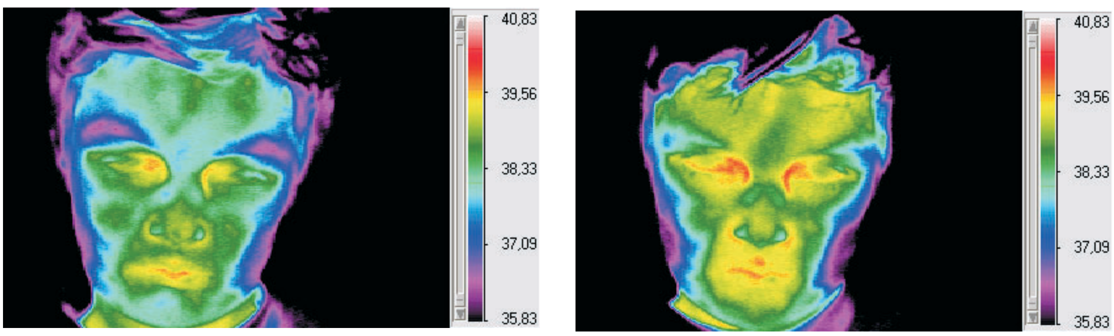


Figure 3

Record of relative temperature distribution in the patient orthostatic disturbances during tilt-test before



Before test
10 minutes later

Figure 4

Images of the patient with orthostatic disturbances during tilt-test before physical exercises

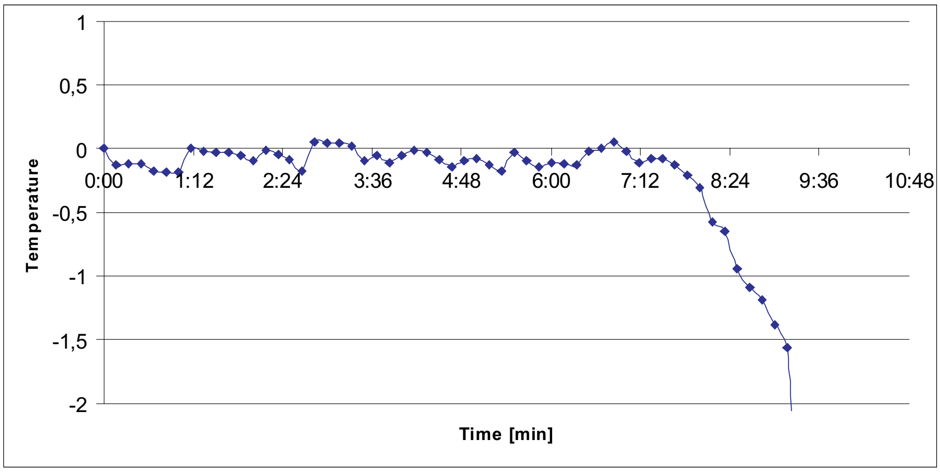
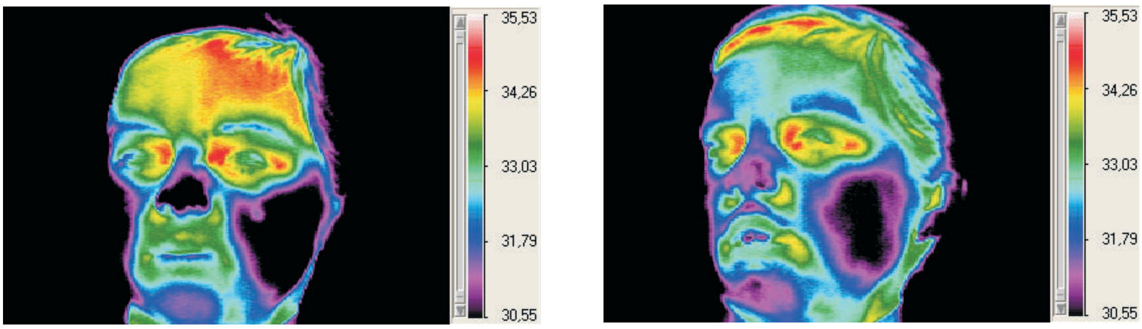


Figure 5
Record of relative temperature distribution in the patient with severe orthostatic disturbances during tilt-test before physical exercises



Before test

9 minutes later - syncope

Figure 6
Images of the patient with severe orthostatic disturbances during tilt-test before physical exercises

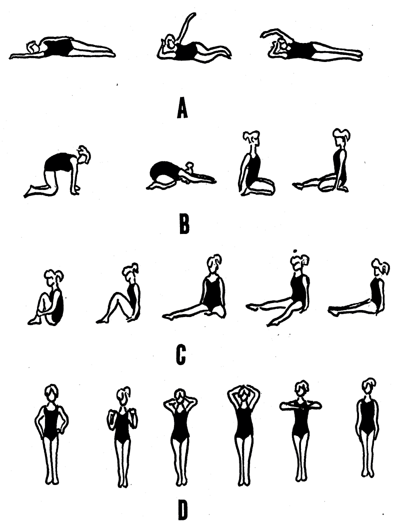


Figure 7
Examples of physical exercises for children
A Exercises in supine position
B Exercises in kneeing position
C Exercises in sitting position
D Exercises in standing position

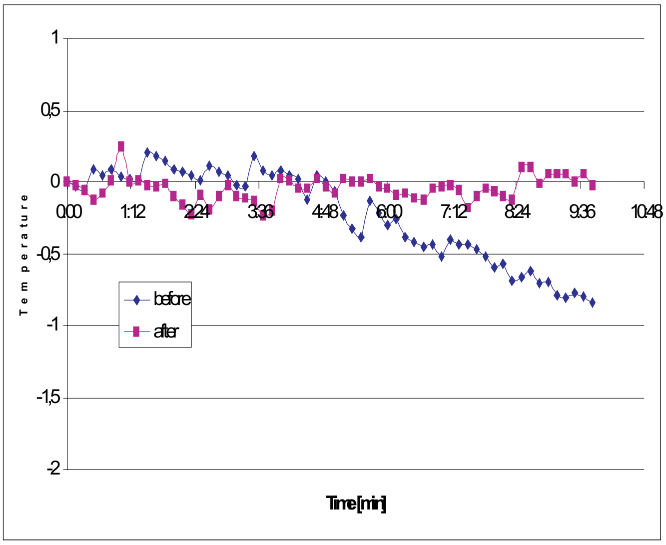


Figure 8

Record of relative temperature distribution in the patient with orthostatic disturbances during tilt-test before and after physical exercises pressure to 40% of its baseline value, mainly caused by the drop of the systolic pressure (from 110 mmHg to 65 mmHg). In both cases the patient fainted.

The thermal images, dynamically processed from the camera showed a significant change in temperature distribution. (Fig. 7).

After 12 months exercise

The temperature parameters of the forehead region in children after the supervised physical exercises did not change in subsequent minutes of the test and were similar to those measured in healthy children (Fig.8). There was a tendency for the heart rate to drop compared to the pre-exercise rate. The mean dynamic pressure in children with orthostatic disorders increased after exercise.

The two children, who fainted and showed a rapid decrease of the frontal region temperature parameters at the baseline examination, had no clinical symptoms of the orthostatic disturbances after exercise. The temperature curves were similar to temperature curves in children without orthostatic disturbances (Fig. 9).

These observations were confirmed by the dynamic infrared thermal images (Fig. 10).

Discussion

Thermal imaging is a method based on remote detection and monitoring of thermal infrared

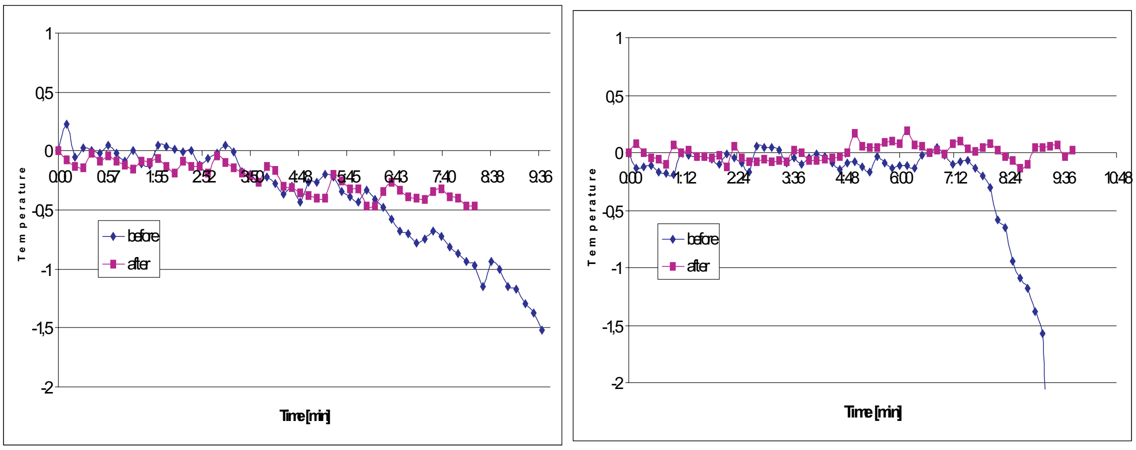


Figure 9
Record of relative temperature distribution in the patients with severe orthostatic disturbance of the tilt-test

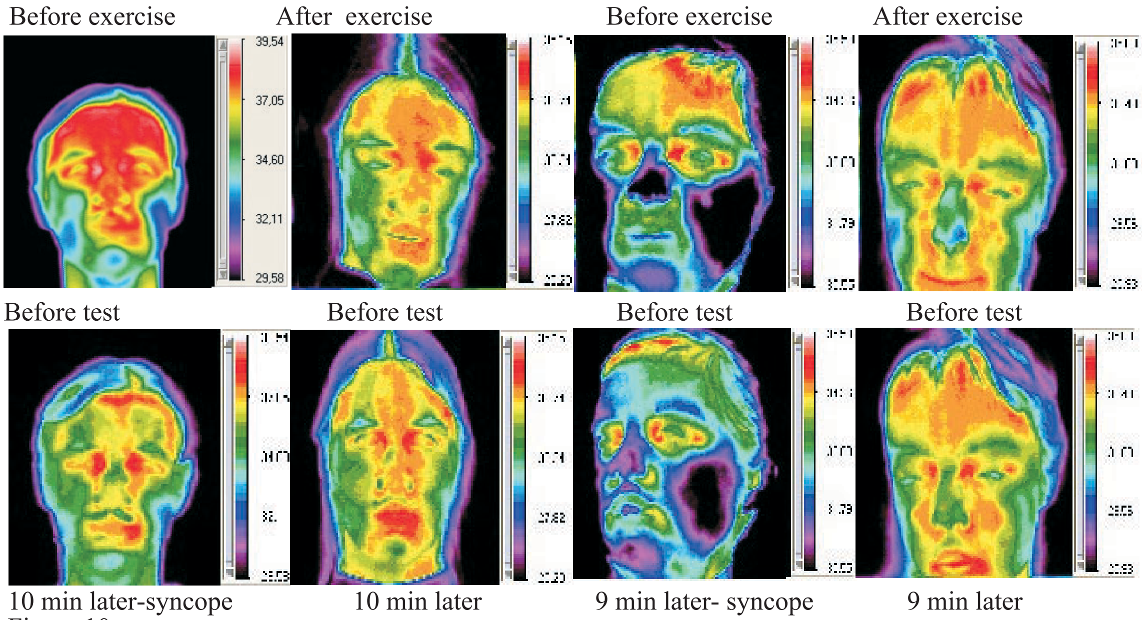


Figure 10
Images of patients with severe orthostatic disturbance of the tilt-test before (syncope in both) and after physical exercises

radiation of a given area, and thus enables temperature measurement without contact.

Temperature measurements rely on the registration of infrared radiation emitted by the body, whose properties are closely connected with the temperature on the body surface.

Thermal imaging techniques are used to supplement the routine diagnostic methods applied in medicine. The main advantage of infrared thermal imaging is its non – invasive character and lack of restrictions conditioned by sex or age. During recent years there is a growing interest in this technique in medicine (1,2, 10, 13, 14, 16).

Previous research on the patho-mechanism of orthostatic disturbances have shown that during a long period in the upright position, the central venous pressure drops, the cardiac output, ejection volume and blood pressure decrease leading to an acceleration of the heart rate.

The pre – faint and fainting stage appear in the phase referred to as the excessive circulatory centralization, which takes place with isovolemia and uncontrolled contraction. A fainting attack can be caused by a decreased tension of resistive vessels.

Apart from the orthostatic test, vasomotor disorders can also be assessed on the basis of the other methods, which are based on generating a fast change of vessel tonus under the control of the autonomous nerve system. These reactions may lead to vessel contraction or dilatation (3, 4, 5, 18).

This study using thermal imaging provides data on the range of temperature changes, which may be related to the blood flow in vessels of the skin of the frontal region in children with orthostatic disorders. Significant differences in temperature measured at reference points have been noted in subsequent minutes of the test in children with functional disorders of the cardiovascular system. The changes become even more significant in patients with severe vasomotor disturbances (19).

Medical management of orthostatic disorders should be multidirectional. Prevention of orthostatic disorders is an important challenge. Among the non – pharmacological methods supervised exercise plays a major role in secondary prevention. Physical exercises improve the vascular reactions of the circulatory system.In our study, regular exercises have brought about the recovery of children from the clinical symptoms of an underlying orthostatic disorder. These effects are supported by the results of thermal imaging. Infrared thermography is a recommended diagnostic procedure for the examination of the vascular system.

Conclusions

1.Infrared thermal imaging is a non-invasive method of for the evaluation of the vascular system. It is useful in the diagnosis of orthostatic disorders in children.

2.The study has shown a decrease of temperature at reference points of the upper part of the body, especially the skin of the frontal region, in children with orthostatic disorders. The decrease in temperature (even by more than 1°C) correlated with clinical symptoms.

3.In children with orthostatic disorders after the physical exercise programme, no differences in temperature parameters of the forehead region have been observed.

4.The exercise regime has led to the disappearance of the clinical symptoms of the orthostatic disorders in the children in this study.

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Temperature changes after manual examination of the cervical spine

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Summary

Objective: Does a manual examination of vertebral segments of the cervical spine affect the temperature distribution on the skin of the dorsal neck ?

Method: 7 non symptomatic female subjects (age: 26 to 46 years) were included in the study. After acclimatisation to a room temperature of 24°C for 15 minutes an infrared thermal image of the dorsal neck was taken. The investigator performed a general side bending of the neck and a manual segmental examination of the levels C3 to C7 to either sides. The mobilising technique was applied for vertebral block in order to re-establish the degree of joint movement. Immediately after each single test thermal images were taken resulting in a series of 14 thermograms. Two regions of interest (ROI) were defined according to the Glamorgan protocol and the side-to-side differences of mean temperatures were calculated.

Results: The mean temperature difference between the right and left region of interest was 0.10 ± 0.08 prior to the examination. All subjects presented with a restricted joint movement of a single intervertebral joint, 5 subjects on the right side (2 on level C4, 2 on level C6, 1 on level C7) and 2 subjects on the left side (level C5 and C7). The mean temperature of the right ROI differed significantly from baseline readings in 6 stages of the examination including mobilisation, but the left ROI changed significantly only after examination of the left intervertebral joint C7 and after mobilisation. However, the side-to- side difference of temperature did not differ significantly from baseline readings.

Conclusion: Non symptomatic vertebral blockage of the spine and manual testing of the joint range of movement does not affect the side-to-side temperature difference of the dorsal neck. However, a significant change of the mean temperature might occur on one side of the neck after manual testing, and mobilisation of a blocked vertebra will affect the temperature readings on both sides of the dorsal neck.

Key words: segmental hypo-mobility, vertebral block, infrared thermal imaging, manual examination

Temperaturveränderungen nach manueller Untersuchung der Halswirbelsäule

Fragestellung: Führt die segmentale manualmedizinische Untersuchung der Halswirbelsäule zu einer Veränderung der Temperaturverteilung an der Nackenhaut ?

Methode: 7 Symptom freie Frauen im Alter zwischen 26 und 46 Jahren wurden untersucht. Nach einer 15 minütigen Anpassung an eine Raumtemperatur von 24°C wurden Infrarotthermogramme der Nackenregion angefertigt. Dann wurde eine passive Seitbeugung der Halswirbelsäule vom Untersucher vorgenommen und die segmentale Beweglichkeit der Intervertebralgelenke C3-C7 geprüft. Im Falle nachgewiesener Blockierungen wurde eine Gelenkmobilisation am Ende der Untersuchungsreihe durchgeführt. Unmittelbar nach jedem Testmanöver wurde ein weiteres Thermogramm aufgezeichnet, sodass pro untersuchter Probandin 14 Thermogramme angefertigt wurden. Zwei Messareale wurden in Übereinstimmung mit der Untersuchungsanleitung aus der Universität Glamorgan definiert und die Seitendifferenz der Temperatur wurde berechnet.

Ergebnisse: Die mittlere Temperaturdifferenz zwischen dem rechten und dem linken Messareal betrug vor der Untersuchung 0.10 ± 0.08 °K. Alle Probandinnen boten ein hypomobiles Segment, 5 Personen an der rechten Seite (2 im Segment C4, 2 im Segment C6, 1 im Segment C7) und 2 Personen an der linken Seite (Segment C5 und C7). Die mittlere Temperatur des rechten Messareals unterschied sich an 6 Untersuchungsschritten signifikant vom Ausgangswert einschließlich nach Mobilisation, währen sich das linke Messareal nur nach der Untersuchung des 7. Intervertebralgelenks und nach Mobilisation signifikant veränderte. Die Seitendifferenz der Temperaturen veränderte sich jedoch zu keinem Zeitpunkt im signifikantem Ausmaß.

Schlussfolgerung: Asymptomatische vertebrale Blockierungen und die manualmedizinische Untersuchung beeinflussen die Temperaturdifferenz zwischen rechter und linker Nackenhaut nicht.Trotzdem können einseitig nach manual-medizinischer Untersuchung signifikante Temperaturänderungen beobachtet werden, und die Mobilisation eines blockierten Segmentes kann beidseitig Temperaturänderungen bedingen.

Key words: segmentale Hypomobilität, Wirbelblockierungh, Infrarot-Thermographie, manual-medizinsche Untersuchung.

Thermology international 2002; 12:147-152

Introduction

Skin temperature over the spine was frequently related to the loss of joint play of inter-vertebral joints. Such vertebral blockages might be associated with disturbed symmetry of the temperature distribution of the body's surface (1,2, 3,4). Goodman et al. determined the confidence interval of side-to-side differences over the spine (5). In the lateral regions of the dorsal neck, 95% of all side-to side differences were within a range of 0.3 °K , for medial regions the temperature difference was 0,2°K respectively.

Several studies established asymmetry of temperature distribution in the skin of the neck and back to be associated with an underlying functional spinal disorder and recovering of temperature symmetry was taken as an indicator of effective therapy (4).

In a previous study (1) the re- establishing of symmetric temperature distribution after manual therapy of blocked vertebral segments was reported. However, at that time the author did not allow for the influence of examination of the spine on temperature distribution.

A pilot study was conducted to answer the question of whether manual examination of vertebral segments of the cervical spine affect the temperature distribution on the skin of the dorsal neck.

Method

7 non symptomatic female subjects (age: 26 to 46 years) were included in the study. All gave oral informed consent to participate in the investigation.

Table 1
Mean side-to-side difference after single steps of examination

SIDE-TO-SIDE DIFFERENCE OF TEMPERATURE	MEAN ± STANDARD DEVIATION
Baseline	0.10 ± 0.08
After side bending to the right side	0.14 ± 0.11
After side bending to the left side	0.14 ± 0.18
After examination of right intervertebral joint C3	0.14 ± 0.16
After examination of left intervertebral joint C3	0.17 ± 0.13
After examination of right intervertebral joint C4	0.16 ± 0.14
After examination of left intervertebral joint C4	0.17 ± 0.17
After examination of right intervertebral joint C5	0.16 ± 0.08
After examination of left intervertebral joint C5	0.16 ± 0.19
After examination of right intervertebral joint C6	0.14 ± 0.13
After examination of left intervertebral joint C6	0.22 ± 0.14
After examination of right intervertebral joint C7	0.17 ± 0.08
After examination of left intervertebral joint C7	0.20 ± 0.13
After mobilisation	0.13 ± 0.10

After acclimatisation to a room temperature of 24°C for 15 minutes an infrared thermal image of the dorsal neck was taken. The investigator performed a general side bending of the neck and a manual segmental examination of the levels C3 to C7 to either sides. For the assessment of segmental mobility, the tranverse process of each vertebral was contacted with the investigators index finger, followed by a gentle side bending with full contact with the vertebra towards the touching finger. This manoeuvre leads normally to rotation of the investigated vertebra to the front (6) and any reduction in the range of this motion was re-

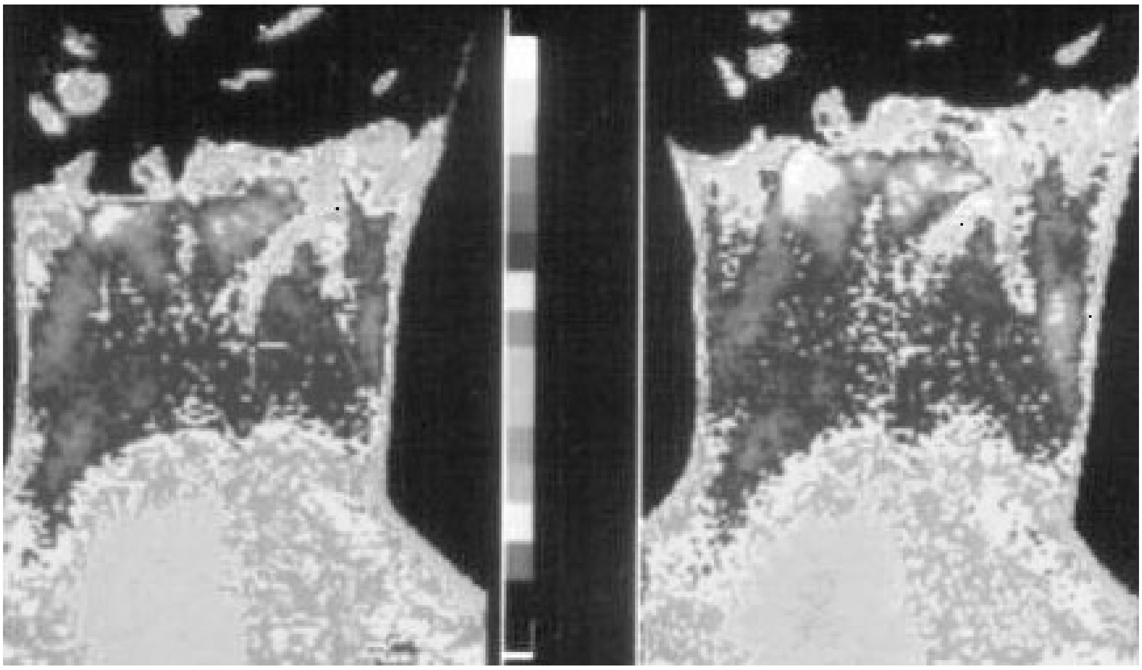

Figure 1
Baseline image (left) and after general bending to the right

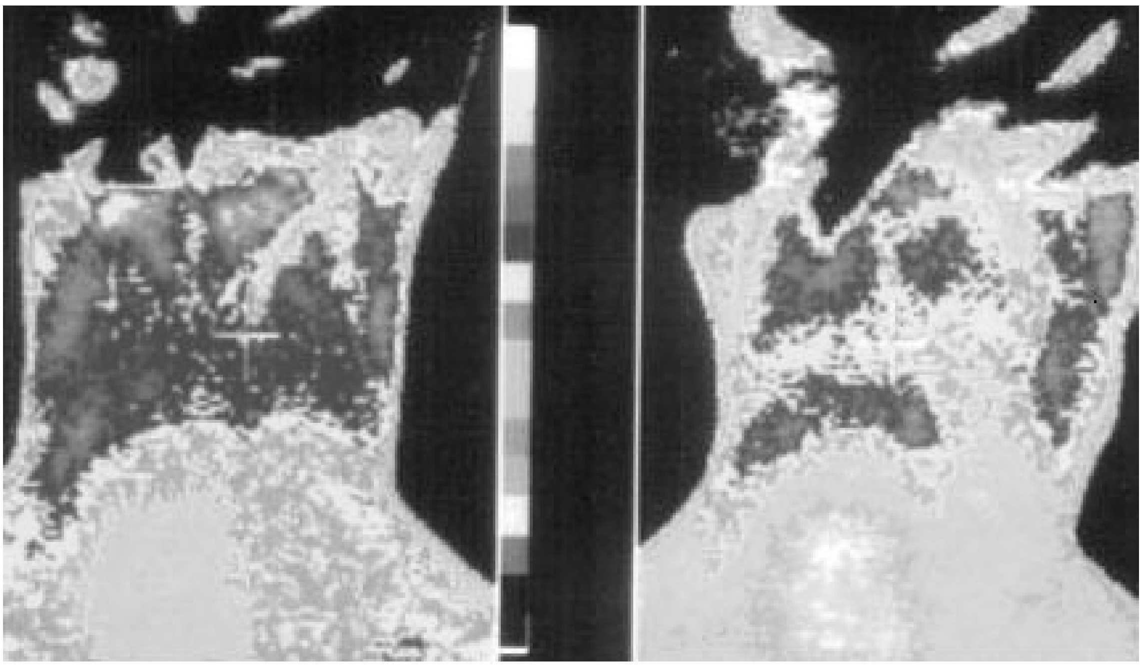

Figure 2
Baseline image (left) and after mobilisation the left intervertebral joint C7.

Table 2
Mean temperatures of the regions of interest after single steps of examination

Region of interest, right side	
* 1-tailed p < 0.05 Wilcoxon testcompared with baseline readings	mean ± standard deviation
Baseline	34.56 ± 0. 77
After side bending to the right side	34.31 ± 0.89 *
After side bending to the left side	34.30 ± 0.94
After examination of right intervertebral joint C3	34.26 ± 0.97 *
After examination of left intervertebral joint C3	34.21 ± 1.00
After examination of right intervertebral joint C4	34.27 ± 0.99
After examination of left intervertebral joint C4	34.20 ± 0.99
After examination of right intervertebral joint C5	34.19 ± 1.03 *
After examination of left intervertebral joint C5	34.11 ± 1.03 *
After examination of right intervertebral joint C6	34.13 ± 1.04 *
After examination of left intervertebral joint C6	34.20 ± 1.04
After examination of right intervertebral joint C7	34.13 ± 1.04
After examination of left intervertebral joint C7	34.10 ± 0.98
After mobilisation to the right side	34.17 ± 0.81 *

Region of interest, left side	
* 1 –tailed p < 0.05 Wilcoxon Test compared with baseline readings	mean ± standard deviation
Baseline	34.49 ± 0.74
After side bending to the right side	34.40 ±0.98
After side bending to the left side	34.31 ±0.97
After examination of right intervertebral joint C3	34.33 ±0.95
After examination of left intervertebral joint C3	34.31 ±1.04
After examination of right intervertebral joint C4	34.29 ±0.97
After examination of left intervertebral joint C4	34.23 ±1.03
After examination of right intervertebral joint C5	34.33 ±0.97
After examination of left intervertebral joint C5	34.19 ±1.10
After examination of right intervertebral joint C6	34.21 ±1.06
After examination of left intervertebral joint C6	34.20 ±0.97
After examination of right intervertebral joint C7	34.21 ±0.97
After examination of left intervertebral joint C7	34.21 ±0.98 *
After mobilisation to the left side	34.19 ±0.81 *

corded as segmental hypo-mobility. Immediately after each single test thermal images were taken resulting in a series of 14 thermograms. In the case of a detected segmental hypo- mobility, a mobilising technique was applied at the end of the examination series in order to re-establish the joint movement.

Two regions of interest (ROI) were defined according to the University of Glamorgan protocol. Mean, maximum, minimum temperature and standard deviation of each ROI were recorded. The side- to-side differences of mean temperatures were determined. Descriptive statistics were calculated. The mean temperature prior to testing was compared with the mean temperatures after each single test using the Wilcoxon test.

Results

The mean temperature difference between the right and left region of interest was 0.10 ± 0.08 prior to the examination (Table 1). No significant change of the side-to-side difference was detected at any stage of the examination.

All subjects presented with a restricted joint play of a single intervertebral joint, 5 subjects on the right side (2 on level C4, 2 on level C6, 1 on level C7) and 2 subjects on the left side (level C5 and C7). The mean temperature of the right ROI differed significantly from baseline readings in 6 stages of the examination (table 2). Side bending to the right (figure 1), examination of right inter- vertebral joint level C3, level C5 either sides, level C6 right side. After mobilisation this was followed by significant differences in the mean temperature compared to baseline reading, but the left ROI changed significantly only after examination of the left intervertebral joint C7 and after mobilisation (figure 2).

Discussion

The manual examination in this study led to an immediate change of the skin temperature of the neck. Despite a acclimatisation period of 15 minutes, the mean temperature decreased further in both investigated regions of interest of the neck. As these temperature changes already occur after general side bending performed without contact with the skin of the neck, it might caused by the examination procedureitself rather than by the time course. The significant change of temperature was seen regularly after mobilisation of a blocked vertebral segment. This finding is in agreement with other reports in the literature (1,2,3).

As the examination induced neither discomfort nor pain in the investigated subject, pain induced vasconstriction of skin vessels does not explain the reduction of local skin temperature that was observed. High muscular tension was related to localized hyperthermia (6,7,8). The information from inter-vertebral joints was correlated with the muscular tone in animal experiments, when the muscular tone was increased with high information flow from receptors for joint position and reduced after blocking this information (9). Such a mechanism may contribute to low regional temperatures after reduction of local muscular tone via information from the investigated joint. Future studies need to assess the local changes of muscular tone, although an appropriate method that can easily be used in clinical studies for the assessment of the muscular tone is not yet available (10).

Occasionally, transient hot spots appeared contra-laterally to the examined side. Weather this local hyperthermia is related to the stretching of the tissue underlying the region of the hot spot or is the reflex response from deep structures to the skin remains unclear. It was reported that manual massage, which is a mechanical manipulation of sof tissues,is followed in healthy subjects by local increase of skin temperature (11).

The subjects investigated in this pilot study presented predominately with vertebral blockages on the right side of the neck. This might be the reason for the phenomenon, that segmental examination more often led to significant changes of temperature in the right region of interest than on the left side of the neck. Furthermore general side bending to the right, but not to the left was followed by a significant change of temperature. However, the relationship between side of segmental hypo-mobility and change of temperature needs to be investigated in a bigger sample of subjects with equally distributed restrictions of vertebral joint play on either side. In addition, a control group without any segmental hypomobility would be desirable.

Conclusion

Manual examination of the cervical spine and restoration of restricted joint play can affect the mean skin temperature of the dorsal spine unilaterally, but does not change the side-to-side difference of temperature.

Temperature changes observed immediately after manual therapy might not be related to the restored joint movement, but might also be caused by manual examination of the cervical spine.

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5th Congress of the Polish Society of Thermology in Zakopane, 27-29 September 2002: Abstracts

TEMPERATURE ELEVATION OF THE ROOT SURFACE IN VITRO DURING ROOT CANAL OBTURATION BY THE CONTINUOUS WAVE OF CONDENSATION TECHNIQUE

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The temperature changes on the outer root surface of 8 extracted human teeth with a single canal during the continuous wave of condensation technique (System B, Analytic, USA) were determined using an infrared thermal imaging camera (ThermaCam SC500, Flir, Sweden). The temperature changes during root canal obturation were recorded at three points (apical, central and coronal) on the outer root surface.

The results showed that the technique of continuous wave of condensation produced a relatively high increase of temperature on the outer root surface. Higher temperatures were recorded in the coronal part of the root (12,4°C; min.- 10,9 °C; max.- 14,5 °C), than in the middle (10,1 °C; min.- 7,7 °C; max.- 11,3 °C) or apical (6,15 °C; min.- 3,0 °C; max.- 12,2 °C) parts.

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TEMPERATURE CHANGES ON THE OUTER ROOT SURFACE DURING ROOT CANAL PREPARATION USING ULTRASONIC UNIT

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The aim of this in vitro study was to measure root surface temperature changes during root canal preparation using the Piezon Master 400 ultrasonic device.

Eight extracted human teeth with a single canal were fixed in the slate and ultrasonic preparation was performed using the Piezon Master 400 ultrasonic device (EMS, Switzerland). The device , which was fitted with 15, 20, 25 and 30 ultrasonic files and set for a minimal continuous flow of irrigation, was operated at full power. The temperature rise during root canal preparations were recorded at three points (apical, central and coronal) on the outer root surface using an infrared thermal imaging camera (ThermaCam SC500, Flir, Sweden).

The results of this in vitro study showed that temperature rise produced during the ultrasonic preparation were below the critical level and therefore should not cause damage to the supporting structures of teeth. Higher temperatures were recorded in the central part of the root (4,7 °C) than in apical and coronal parts (2,6 °C and 3,7 °C, respectively).

ROOT SURFACE TEMPERATURE RISE PRODUCED BY INJECTED THERMO-PLASTICIZED GUTTA-PERCHA

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This in vitro study compared root surface temperature changes during canal filling by Ultrafil and Obtura techniques.

Fourteen extracted teeth with a single canal were used .The teeth were divided into two groups, mounted in a slate and obturated with thermo-plasticized gutta-percha by Ultrafil (Hygenic, USA) (70 °C) and Obtura (Spartan, USA) (160 °C) techniques. Temperature changes were recorded using the ThermaCam SC500 infrared thermal imaging camera (Flir, Sweden).

The results of this in vitro study showed that during the injection of thermo-plasticized gutta-percha the temperature increase does not reach a level that is a danger to periodontal tissues. Higher temperature changes were generated by the Obtura technique (9,8 °C) than by the Ultrafil (2,1 °C) technique.

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KINETICS OF THE TEMPERATURE INCREASE OF PERIODONTAL TISSUES AFTER COOLING IN PATIENTS WITH INSULIN-DEPENDENT DIABETES MELLITUS-PRELIMINARY STUDIES

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It has been established that patients with long-term and decompensated type 1 diabetes develop inflammatory changes of the periodontium during their developmental stages more often than in healthy subects. Other changes frequently observed in diabetic patients are in the vascular system of the retina (microangipathy of the retina), in the kidney (nephropathies) and in nervous tissue (neuropathies). Similar pathological changes may also develop in other tissues, e.g. in periodontium.

It has not, however, been established which risk factors are the most important in the aethiopathogenesis of periodontal diseases accompanying diabetes. Recently, much attention has been paid to the role of the long-term metabolic decompensation which changes the response of the periodontium tissues to local irritating agents. The development of vascular complications can also be due to large variations in the blood glucose level. Results of the thermographic study of periodontal tissues in the vicinity of incisive teeth have shown higher temperatures in the group of insulin dependent diabetes melllitus (=IDDM) patients compared with healthy subjects (author's studies).

The aim of this study was to assess the dynamics of the temperature increase in children and adolescents with diabetes type1. The subjects were 32 IDDM patients aged from 10 to 19yrs. with documented diabetic history of 4 to 14 years. High values of glycosylated haemoglobin HbA1>9,5% indicated metabolic decompensation. A control group included 18 healthy adolescents. Thermographic measurements were performed with an AGA Thermovision System 680.

The temperature changes (Tn) were measured at fixed time intervals after application of the cooling agent (1, 2, 3 and 4 minutes after cooling). The interpretation was based on the mean temperature values. The results confirmed the data obtained in a study of peripheral circulation in fingers, that the most significant temperature changes are observed in the first minutes after the application of the cooling agent.

SKIN BLOOD FLOW CHANGES UNDER SIMULATED ALTITUDE HYPOXIA CONDITIONS

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Performance of modern aircraft depends on the flight task being based on human psycho-physiological ability. One of the main hazards in aviation is hypoxia and low ambient temperature. It is well known that the circulation in man may be modified by ambient temperature. However, the blood volume redistributed under hypoxic conditions leads to an increase of perfusion in the central organs (heart, brain) and decrease of the peripheral tissues. However, there is lack of a clear explanation of the peripheral blood flow role in the mechanism of circulatory changes in literature.

The goal of this study was to estimate skin blood flow and temperature distribution on the skin surface simultaneously under simulated hypoxia conditions and considering subjects thermal status.

Healthy male, volunteers (n=9) aged 25 – 30, took part in this study. The experiment was conducted in a thermo-chamber, in thermal comfort and discomfort conditions (for the naked body) Ta 26 and 20°C. To simulate hypoxia conditions gaseous mixture (nitrogen-oxygen) with the oxygen content corresponding 7500 m o.s.l. altitude was used. Peripheral blood flow changes were estimated based on the continuous flow meter (SBF) (PeriFlux System 5000) at the tip of the index finger. Thermal images of the palm (Ts1) and forearm (Ts2) skin surface area were captured by the system THV 900 (Agema Infrared System). Thermograms were recorded at the 20th minute of adaptation period and then every minute during hypoxic mixture breathing and every 5th minute during the recovery period.

Under simulated hypoxic conditions a significant decrease of the Ts1 and Ts2 values was observed in comparison to the control conditions. The range and dynamics of these changes differed one from another reporting to the analyzed body area and ambient temperature. The lowest values were recorded under thermal discomfort conditions in the palm area, however in the same time an increase of the perfusion in fingertips was observed. Statistically significant increase of the SBF was noticed in +20°C ambient temperature only.

We can conclude that breathing hypoxic mixture simulating altitude 7500 m o.s.l. exposure causes decrease of the mean skin temperature in analyzed area reporting to the ambient temperature. As a consequence skin blood flow should be lowered which was not proven by perfusion measurements at tip of the index finger

STATISTICAL PARAMETERS OF THERMOGRAPHIC IMAGES FOR EARLY DIAGNOSIS OF BREAST DISEASES

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In this paper we present the results of analysis of thermal images of breasts for early detection of disease, with special application to breast cancers. The thermal image can be characterized by many parameters, such as statistical data of the first and second order. In this work, the mean value, standard deviation, histogram modality and steepness, as well as energy and entropy were considered. The thermograms from two groups of subjects were investigated, one with breast cancer changes, and healthy controls without changes. The first analysis confirmed that first order statistical parameters do not precisely discriminate healthy and non-healthy patients. This means that other parameters must be included in the investigation. We also present preliminary results using geometrical and structural parameters, together with second order analysis which is able to distinguish the two different classes of image. This study is the synthesis of application of the statistical parameters of thermal images used for patient classification. The results are obtained using Matlab software, and is an introduction for more advanced classification based on neural networks.

QUANTUM WELL AND THERMAL DETECTORS – NEW TRENDS IN INFRARED TECHNOLOGY

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In this paper, the comparison of uncooled thermal and extensively cooled QWIP (Quantum Well Infrared Photodetector) detectors are briefly presented. Different types of QWIP detectors have been described. The limits of detectivity both for thermal and photon detectors are discussed. Today, significant progress is observed in infrared technology. This is due to increasing interest of infrared sensitive equipment, especially in the domain of uncooled devices, which are much cheaper yet with satisfactory parameters. Such detectors are widely used for e.g.: thermal inspection, observation, and maintenance. On the other hand very precise quantum detectors are still under development. The most efficient quantum detection based on MCT (HgCdTe) has now a competitor which uses traditional wide band-gap semiconductor (AlxGa1-xAs/GaAs), where the carrier excitation takes place in a quantum well. Both responsivity and detectivity of quantum infrared detectors are a function of wavelength, and do not depend on spectral range.

THERMAL WAVE METHOD - LIMITS AND POTENTIALITIES OF ACTIVE THERMOGRAPHY IN BIOLOGY AND MEDICINE

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In this paper we present the basis and preliminary application of lock-in and pulse thermography for Non Destructive Testing (NDT). 3D modelling is presented to confirm usefulness of simple analytical solutions, and to setup the experiments. As an example, the thickness of thin film coatings is briefly described. Active thermography is the method where a sample is heated by an external energy and the 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 thermographic methods can be for measuring skin thickness, inflammatory regions, density of tissues, blood flow, etc

A COMPARISON OF THE FACES OF MONOZYGOTIC TWINS AND THERMAL PHENOTYPES

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Zaklad Medycyny Sadowej PAM, al. Powstañców Wielkopolskich 72 , 70-111 Szczecin

There have been numerous studies on twins that have focused on morphological differences and delineation of the factors predefining emergence of the particular changes. A literature analysis of twin related research has shown that the question of differences in thermal phenotypes of monozygotic twins has not yet been considered.

The first attempt to describe the differentiation of the monozygotic twins' thermal phenotypes was undertaken in August of 2001, on the IV European Twins Festival in Szczecin. This study was an attempt to describe a differentiation of thermal phenotypes of monozygotic twins (MZ) faces, and an attempt to compare the thermograms of MZ and dizygotic twins (DZ). The study was based on thermographic measurements of 30 monozygotic twin pairs and 10 dizygotic twin pairs. Zygosity of the twins was determined through the PCR method and the research was simultaneously carried out in the Hemogenetic Lab. of The Forensic Medicine Department at Szczecin. The thermographic recordings were made with an infrared (IR) camera ThermaCAM ^{TM} SC500. Facial thermograms were recorded for each pair. In order to provide better conditions for more accurate comparative analysis the twins were imaged together on one thermogram.

The morphologic differentiation of temperatures' distribution the MZ twins pairs shows a very high level of intra-pair similarity. In the studies of MZ twins the thermograms of the face showed individual thermal symmetry, and each face was divided into the left and the right half. Similar asymmetry was found within pairs of twins.

With the use of a"Threshold temperature" function the proportional participation of particular temperatures was evaluated. A 0,5°C temperature span was established. The largest proportional participation for the MZ twins was at 34-34,5 °C and 33,5-34 °C for the DZ twins.

Mutual, intra-pair-similarity was computed using Ward's minimum variance method to evaluate the level of Euclidean distances between the objects. They were found to be very small and they did not exceed 25 units for a 100 units scale.

Thermal areas of the face containing "threshold" temperatures were also analyzed by means of Zeiss Imaging Processing Software (KS300) installed on PC (PII 350, Matrox Milenium graphics card). Thermograms were imported directly from the image files into Adobe graphics software. A selection of the particular elemental area was made with the tolerance of 5 pixels. In order to carry out the proper morphometric measurements the elements were pasted into KS300. The artifacts were eliminated with the use of a built-in software module which separates the objects with extreme characteristics. The procedure allowed for direct comparison of the MZ and DZ thermal areas and established the level of selected thermal elements' morphological similarity. A very high level of intra-pair similarity was found among MZ pairs in comparison to DZ pairs.

THERMAL EMISSION FROM THE SHOULDER GIRDLE REGION IN MASTECTOMIZED WOMEN

Danuta Deboa, Miroslaw Parafiniuk, Agnieszka Kempiñska, Alicja Walczak

Department of Forensic medicine (Head: Dr. habil. Miroslaw Parafiniuk), Pomeranian Academy of Medicine
Department of Hygiene and Epidemiology (Head: Prof. Dr. Alicja Walczak), Pomeranian Academy of Medicine

Measurement of thermal radiation is increasingly accepted as a method for assessment of local circulation, particularly in neoplastic and inflammatory conditions.

Mastectomy combined with axillary lymphadenectomy frequently leads to abnormal lymphatic drainage in this region, resulting in lymph retention and chronic edema around the shoulder girdle.

In an effort to reveal disorders of peripheral circulation, we have measured thermal radiation from the shoulder girdle and breasts of 30 women after total or partial mastectomy combined with lymph node dissection. The time from surgery varied case by case, from a few months to some years.

All measurements were performed at standard temperature and humidity. Temperature distribution along lines from the base of the neck to the middle of the palms on the front side and similarly on the rear side was recorded. The armpits were studied separately.

In some patients there was a left-right asymmetry in temperature distribution without evidence of lymph retention. Temperature distribution was almost perfectly symmetric in some women. The greatest differences were noted for armpits, with temperatures higher on the operated side.

TRIAL OF INVESTIGATION THE THERMOGRAPHY FOR THE DIAGNOSIS OF PIGMENTED SKIN NEVI.

Mikulska D.[1], Róýewicka M.[1], R. Maleszka R.[1], Parafiniuk M.[2], Szydùowski Ù.[2]

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Malignant melanoma is the leading cause of death from disorders of the skin. A high number of pigmented skin nevi is regarded as a predisposing factor for malignant melanoma development. Prognosis and survival in melanoma patients is depended on the early diagnosis of this cancer. The non-invasive method of the pigmented skin nevi examination is still not completely solved problem. According to the literature, opinions differ on the usage of thermography in the diagnosis of pigmented skin lesions.

In our investigation we tried to apply practically the thermal imaging (using Therma CAM TM SC 500 camera) in the diagnosis of the pigmented skin nevi. The range of temperature (TR) was measured during the examination of every pigmented lesion. TR was defined as the difference between the maximal and minimal temperature within each nevus. The fourth - grade scale was stated as follows: I. TR value up to 1 °C; II. TR from 1.1°C –to 1.5°C; III. TR from 1.6 °C to 2.1°C; IV TR value over 2.2°C. TR values for the pigmented lesions were mostly in the grade I. Early diagnosis of melanocytic nevi was based on ABCDE rules (American Cancer Society) and dermatoscopy. Molles stated atypical findings according to ABCDE rules and these were excised and the diagnosis was based on histo-pa thology. A correlation was found between TR grade and the nevi examination due to ABCDE rules, dermatoscopy and histopathological examination results. There were no atypical findings in cases of pigmented nevi in grade I. Some of pigmented skin nevae in grade II and most of lesions in grade III were found to be atypical.

Thermography may be useful in differential diagnosis of pigmented lesion. Further work is to be undertaken to confirm these findings.

THERMOGRAPHIC ASSESSMENT OF RAYNAUD'S SYNDROME IN CHRONIC HEMODIALYSIS PATIENTS

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Vascular damage occurring in hemodialysis patients, superimposed on the arteriovenous shunt circulation can lead to the development of Raynaud's syndrome (RS). Non-invasive thermography is routinely used for cold stress assessment in the diagnosis of RS. The aim of the study was to evaluate the frequency of RS in chronic hemodialysis patients by thermographic investigation. The study group comprised 21 chronic hemodialysis patients (15 female, 6 male, mean age 32.6±15.0 years). Ten healthy age-matched individuals (6 female, 4 male) served as controls. The Cold Stress Test (CTS) was performed in all subjects. Thermographic evaluation of both hands with the use of Inframetrics 760 camera was conducted at baseline and every 10 seconds for the 10-minute period following the cooling of both hands with water immersion. The measurements were performed on a day between the dialysis sessions. RS was diagnosed provided that CTS was deemed to be positive i.e. when CTS thermographic measurements revealed increased negative temperature gradient towards the fingers. *Results*: RS was found in these dialysis patients significantly more often than in the study group (11/21 vs 1/10, respectively; $p<0.05$). Interestingly, the dialysis patients with RS were treated with dialysis for a significantly shorter time than patients without RS (52.2±42.5 vs 89.8±54.2 months on dialysis, $p<0.05$). Moreover, the time of the restoration of normal temperature in cooled hands was significantly longer in the hands with arteriovenous shunts than in the shunt-free hands. Based on our results, it might be concluded that RS is a frequent finding in hemodi alysis patients. However, it might be suggested that some autoregulatory mechanisms may play a role in the attenuation of RS symptoms in long-term dialysis patients.

THERMOGRAPHIC EVALUATION OF CONSERVATIVE TREATMENT WITH GLYCOSAMINOGLYCANS AND PROSTAGLANDINS FOR CHRONIC LOWER EXTREMITIES ISCHEMIA

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Polish Air Force Institute of Aviation Medicine, Warsaw

In this study the use of thermographic monitoring for the assessment of peripheral circulation after treatment with glycosaminoglycans and prostaglandins was evaluated. 40 patients with chronic lower extremities ischemia were randomly allocated into two groups of 20. All patients had thermographic assessment and ankle-brachial blood pressure index. All measurements were performed during the morning hours, under constant physical conditions of the environment in accordance to standardization requirements.

The thermographic evaluation was performed prior and post treatment using an Agema Thermovision 900 equipment The tests were performed within a special compartment with constant ambient temperature of 20°C (±1°C) and humidity of 60%. The distance between camera and patient was fixed at 3,7 m.

The mean temperature of the investigated area of extremities in the group treated with glycosaminoglycans was 28,65°C (±1,49) at the right side and 28,90°C at the left. After treatment the thermographic evaluation showed an increase of the mean temperature of 0,63°C at the right side and 0,76°C at the left.

The mean temperature of the investigated area of extremities in the group treated with prostaglandins was 28,83°C (±1,39) at the right side and 29,09°C at the left. After treatment there was increase of average temperature of 0,65 and 0,71°C respectively.

In conclusion thermographic assessment as a non-i nvasive method can be:

·An auxiliary diagnostic method for lower extremities circulation disturbances;

·used for the evaluation of effectiveness in conservative treatment

STATIC THERMOGRAPHY (TG) IN STUDIES OF VASCULAR ACCESS IN HEMODIALYZED SUBJECTS

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Study supported by the KBN scientific research grant 7 T11E 037 20

Complications of vascular access are among the most frequent causes of morbidity in chronically dialyzed patients and may significantly decrease dialysis adequacy. Thrombi within the fistula, strictures or aneurysms, abnormal blood flow, non-physiological blood pressure values in the course of hemodialysis (HD) treatment may lead to re-circulation and a decreased effective clearance (Kdeff). The diagnosis of the type of fistula malfunction is predominantly based on invasive methods (fistulography, angiography) or non-invasive procedures (color Doppler ultra sound). From the urea kinetic modeling it is possible to calculate the dialysis index Kt/V, Kdeff and the percentage re-circulation (%R). The evaluation of vascular access using thermography has only been described in a small number of publications. Static thermography, is a non-invasive, simple and rapid method which can be used at the bedside. It was employed in the evaluation of Cimino-Brescia fistula in 15 chronically hemodialyzed subjects aged 14-70 years. The average HD treatment was 5.8 years (SD=3.9). Having cooled the forearm by immersion in water at 10° C for 5 minutes and having dried the skin, a thermographic camera (V-20ER005-25, Vigo System, Warsaw, Poland) equipped with a HgCdTe detector with thermoelectric cooling. The temperature resolution of the camera was 0.05° C, and the 1% measurement accuracy was regarded sufficient. The acquisition time for one scan was approximately 25 seconds. Twenty-five scans were performed on each patient and were subsequently further processed and analyzed. In each patient, the value of Kt/V, Kdeff and %R were calculated. The analysis of thermographic scans was based on a semi-quantitative scale, where scores were used to describe the degree of pathology of the fistula and the forearm vascular system. In the majority of patients, the TG scans were verified by colour Doppler ultra sound.

Results: The analysis of 90 thermograms (6 from each subect, taken after 25, 50, 100, 150 and 300 seconds, with and without cooling) yielded results that were comparable to results achieved in X-ray fistulography. Doppler ultra sound provided a precise calculation of blood flow and fistula diameters at sites recognized as abnormal, thus confirming the strictures or dilatations of the fistulas. No correlation was obtained between the score assigned in fistula evaluation on the semi-quantitative scale and %R (r=0.06, p=0.8), or the value of %R calculated in the basis of Kdeff (r=-0.11, p=0.7) (Spearman's rank correlation test).

Conclusions: Static thermography may be regarded as an equivalent of fistulography, without the negative effects of contrast medium. The patients did not report any negative effects of upper extremity cooling prior to the study. The analysis of thermograms and discussing the results with nursing staff responsible for fistula needling allowed for the improvement of dialysis adequacy in 4 patients by lowering the re-circulation. The congruence of TG scans and color Doppler ultrasonograms enables the recognition with static TG as the first and in some circumstances essential diagnostic tool in fistula assessment in each case of suspected fistula dysfunction.

MECHANICAL PROVOCATION TESTS IN THERMAL IMAGING

Kurt Ammer

Ludig Boltzmann Research Institute for Physical Diagnostics, Vienna

Thermal Physiology Lab, School of Computing, University of Glamorgan, Pontypridd, U.K

Positioning and exercise are used as a form of mechanical stress in a variety of diseases for the enhancement of thermal changes on the surface of the human body. Exposure to vibration may also induce changes of perfusion, which can be identified by thermal imaging.

Typewriting can be regarded as a challenge that combines exercise and exposition to some kind of vibration, which may result in increased heat of working muscles and/or low temperature readings over the finger-tips due to disturbed perfusion.

The risk of developing disorders caused by hand-transmitted vibration are currently predicted in ISO 5348 (1986), British Standard (1987) and similar standards. However, a standardised vibration exposure test is not yet available.

Indications for mechanical stress testing are suspected motor deficit (neurogenic or disuse induced), thoracic outlet syndrome (TOS), repetitive strain injury (RSI) and vibration induced white fingers.

This paper reviews some protocols and study results obtained from studies dealing with mechanical stress testing. In repetitive strain injury, the influence of the duration of typewriting for the occurrence of cold fingers was shown. In thoracic outlet syndrome, the protocol for positioning and temperature evaluation is described. A high inter- and intra-rater reliability of the temperature evaluation was found. The influence of the fist manoever on finger temperature and the beneficial effects of exercise- induced posture correction on the temperature difference between index and little finger was reported. In patients with peroneal palsy of either radicular or peripheral origin, the enhancement of temperature changes by exercise was clearly shown.

Mechanical stress can be used successfully for the enhancement of thermal changes on the surface of the human body that can be detected and recorded by thermal imaging.

PROCESSING OF SEQUENTIAL THERMOGRAPHIC (TG) SCANS IN VASCULAR ACCESS EVALUATION

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Study supported by the KBN scientific research grant 7 T11E 037 20

In the described studies the authors attempted to evaluate the vascular system in hemodialyzed patients with sugically created A-V fistulas in the forearm. TG scans were obtained using a thermographic camera with a single detector. The TG pictures resulted from scanning the scene in two dimensions. Having cooled the forearm by immer-s ion in water at 10ºC for 5 minutes and having dried the skin, 15-18 scans were acquired at 25-seconds intervals. A TG scan was registered before cooling to assess dynamic changes. In order to determine dynamic parameters of temperature changes, it is necessary to precisely match the subsequent thermograms. To avoid the necessity of introducing restrictive laboratory conditions, the authors proposed a set of techniques for image sequence processing that would compensate for not keeping the object during the measurement in fixed position. The algorithm was as follows: 1. Median filtering. 2. Subpixel horizontal line displacement correction. 3. Identification of the whole object (forearm) shift in front of the camera through searching for corresponding pixels in the consecutive images (for a preselected set of 15 points) – the block-matching technique was applied. 4. Subpixel correction of detected shifts. 5. Correction of local shifts within the object based on the assumption of temperature monotonic growth. The prepared sequence of TG scans may then be used to plot a map of time constants for the temperature changes approximated by exponential law at each point of the image (Fig.1b). These computations, with exponential regression applied for averaging, indicated that in the vicinity of the large vessels time constants amounted to about 50 seconds, while in other regions their values were often above 200 seconds. A model with a single time constant yielded temperature curves that were only slightly different than the actual values. When the temperature increased within intervals of 5-14ºC, the average model error equaled approximately 0.5ºC with the same SD value. Comparing the temperature changes obtained from model and measurement, the authors found that in the vicinity of blood vessels initially the temperature rose faster than the modeling curve, while falling below that line in the second phase. In regions devoid of large vessels, the relative changes of actual and modeled curves were opposite (Fig.1c). Fig.1d presents the map of weighted sums of deviations from the model. The weight values were +1 for the scans numbered 2-8, and –1 for the later scans. The results obtained confirmed the value of the image processing techniques for the evaluation of dynamic features of temperature changes on the forearm surface. These are used to indicate the blood vessel structure without the necessity for precise immobilization of the forearm in front of the camera.

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REFERENCE DATABASE OF NORMAL THERMAL IMAGES OF HEALTHY SUBJECTS

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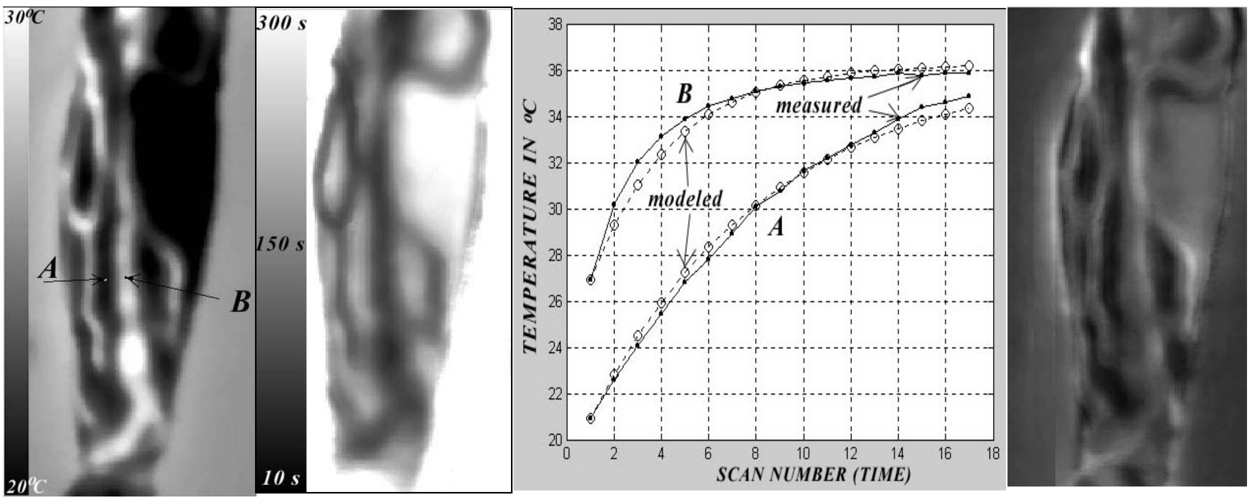
Temperature maps in so called normals with respect to the symmetry of temperature distribution on the body's surface were published in the eighties by Uematsu, Goodman, and restricted to temperature readings over joints by Ring and Engel. However, these papers did not describe the definition of health in their selection criteria nor did they meet the requirements for a representative sample for the population in a defined geographical area. Anthropometrical features such as weight, height, body mass index and gender had not been considered.

Standardized positions of the body for image capturing and definition of reproducible placement of



A) b) c) d)

Fig.1.a. A forearm of a hemodialyzed patient: the first TG scan in the sequence. b. The map of plotted time constants. c. The comparison of the modeled and measured temperature changes for points A and B. d. The map of weighted deviations from the applied model (see details in text).

regions of interest (ROI) for temperature measurements can reduce systematic errors. Images captured and analyzed in a clearly defined protocol will show mainly the individual variations of temperature distribution, and deviations from these standard images would be suggestive for a physical dysfunction.

We have established a protocol for capturing a series of images that covers the whole body of a healthy subect. The protocol defines a healthy subject as someone who had no problems with mobility, no difficulty in caring for himself, no restrictions in performing normal activities, experienced no pain or discomfort and was not suffering from anxiety or depression. A total of 24 views of the body were specified and within these views, a total of 87 regions of interest (ROI) were defined. The repeatability of some standard views by different investigators and the inter- and intra-rater reliability of temperature readings from selected regions of interest was investigated.

The consistency of the standard views "Face", "Anterior Left Arm" and "Dorsal Hands" was evaluated. The distance, measured in pixels, from the upper or the lower edge of the image to anatomical landmarks was used for evaluation. The cross section tool of Ctherm was used for the determination of distances.

The inter-rater reliability of temperature measurements of 3 regions of interest on the view "Anterior Arm" was evaluated in five newly trained investigators. Another experiment evaluated which shape of the ROI over the knee showed the highest degree of repeatability. A circle, a square and an hourglass shaped area were applied to the same image in the standard view "Anterior Knee" by three newly trained investigators.

Positioning for the face varied in very narrow way and hand views varied in a wider range than the positioning of the face. Related to the difficulty of positioning the arm, where 3 landmarks must be placed within the image, repeatability of this view was slightly better than the positioning of hands. Using the hourglass shape revealed a better precision of temperature readings than the other shapes. The reason for that might be that the alignment of the region of interest is easiest to perform with the hourglass shape. This evaluation resulted in deviations from the mean temperature of the region of interest between 0.001 and 0.10 °K at the elbow, between 0.06 and 0.27 at the upper arm and between 0.02 and 0.1 at the upper arm. Mean difference between 1st and 2nd measurement of individual investigators was 0.024.

The repeatability of standard views vary by the body regions investigated. However, standards views can be reproduced within a narrow range. Interrater reliability coefficient alpha and ICC of the ROI "Lower Arm", and the hourglass shaped ROI at the anterior knee confirmed excellent repeatability of ROI placement. Reference values for the surface temperature of body regions based on images captured according to our protocol will reflect mainly the individual temperature variation.

ERRORS AND ARTEFACTS IN THERMAL IMAGING

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School of Computing, University of Glamorgan, Pontypridd CF37 1DL United Kingdom

Infra red thermal imaging is a powerful tool for the study of human body temperature. Modern thermal imaging systems are highly developed, and produce a digital two-dimensional image of skin temperature. In clinical practice there are a number of essential steps to apply the technique to the examination of the human body. There are now a number of factors recommended for clinical practice, which are needed for reliable and reproducible thermal imaging. Ignoring any one of these steps leaves the investigation open to error, and thus reducing the clinical acceptance and understanding of thermal imaging for medical applications. A knowledge of normal thermal patterns and temperatures is required, and awareness of clinical causes for those patterns to be changed, with increased or decreased temperatures.

The critical factors in a thermal imaging protocol begin with the patient. Prior information to and from the patient is needed. To register any possible effects of drugs, physiotherapy or surgery on body temperature, the patient is always asked to rest in a cubicle, with the examination areas unclothed for a minimum of 10 minutes at a defined ambient temperature.

The equipment must be of proven stability and accuracy, with the IR camera mounted on a parallax free stand. The examination room must be at a controlled temperature, usually from 20°C (used for inflammatory studies) t0 24°C (used for vasomotor studies). Standard views of each required area of the body are essential, and the angle between camera and patient should be around 90° whenever possible. Standard distances are also advised, since resolution (thermal and spatial) are usually decreased as scanning distance increases.

Image analysis must also be standardized. Regions of interest are frequently chosen on subjective parameters, which have been shown to be irre producible even by the same investigator on the same image with repeated analysis. A protocol for defined regions of interest based on anatomical limits is the only sure way to minimize inter operator variation.

Finally, reporting the images requires al relevant data on the temperature range and level of the camera setting, the location of regions of interest and their data, and the conditions under which the examination was carried out. Failure in any of these parameters can lead to sizable errors, and misinterpretation of the findings.

Examples will be given of false results in thermal imaging from failure of the investigator to understand the essential factors for the patient examination. Inadequate camera settings, or unproven stability after starting the camera have been found to significantly alter the final image. Errors resulting from subjective sizing and placement of regions of interest also show significant variations, all of which can be avoided. The importance of standardized reporting is evident when comparisons over time are required. In medical-legal issues, each image must be clearly identified, and shown to be taken under comparable conditions. No less a standard is required for normal clinical work with this technique. Knowledge of the normal patterns, and causes of hyperthermia or hypothermia are also important to both the technician and the physician using this technique.

Under correct conditions good reproducible images are obtained from which reliable thermal data can be extracted. Poor technique results in avoidable errors and artifacts, which confuse and even invalidate the clinical findings. A good knowledge of thermal physiology is important, but is not enough, if protocols for image capture and analysis are not carefully followed. Modern hardware and software have transformed this technique in recent years, the limitations are more subjective than obective. User-friendly software can provide prompts to help the inexperienced user of thermal imaging.

News in Thermology

9th European Congress of Thermology

Prof.Dr.Anna Jung is preparing the organisation of the 9th European Congress of Thermology, which will take place in Krakow May 30 to June 1, 2003. The conference will be combined with 6th National Congress of the Polish Association of Thermology and the 16th Thermological Symposium of the Austrian Society of Thermology.

The **international scientific board** of this major thermology conference is headed by Prof Dr. Anna Jung, Poland. She is assisted by

Prof. Francis Ring, U.K,
Kevin Howell, U.K
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Krakow

the European City of Culture for 2000, is one of the most visited cities in Poland. This former capital city has a wealth of preserved buildings and culture over many centuries. It is a major centre of science and learning, its renowned Jagellonian University is one of the oldest in Europe from 1466. The University Museum contains many items dating back to Copernicus, who received his degree there. The main square is the largest medieval market square in Europe. In the centre is the famous Cloth Hall from the 12th century, which today is a centre for local arts, crafts and souvenirs. A few hundred meters away stands the Royal Castle commanding a view of the whole city. The origins of this historic building date back to the year 1000 AD.

The Conference Centre is a pleasant building in the old town district belonging to the Polish Military. It has art deco styling typical of the early 20th Century, with a conference hall and exhibition area on the first floor.

Campanile Hotel is conveniently located a few minutes walk away and is less than 5 minutes walk to the old city square, with its abundance of restaurants etc.

Krakow Airport Balice is near the city, and can be reached by bus and taxi. Good International connections include Chicago, London, Paris, and Rome. Regular daily flights link to Warsaw's International Airport.

Polish National Tourist Websites

Austria	polska@netway.at
Belgium	www.polska-be.com
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UK	www.visitpoland.org
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Topics of the Conference

Thermal physiology, skin temperature, thermoregulation, cClinical applications of thermal imaging and related techniques (LDI, U/S, MIR), Raynaud's phenomenon, hand-arm syndrome, complex regional pain syndrome, neuromuscular conditions, peripheral vascular diseases, deep vein thrombosis, haemodialysis, skin graft monitoring, paediatric diseases, rheumatology, Image quantitation, Developments in Infra red camera systems, Software and image processing, databases and normal thermograms, standards of IR imaging

Outline programme

Thursday 29th May

14.00-17.00 Registration at The Cultural Institute Zyblikiewicza 1.

Evening Welcome reception party

Friday 30th

09.00 – 17.30 Congress opens.
I- IV Human body temperature physiology and technical developments

Saturday 31st May

08.30 – 17.30
V-IX Clinical applications of thermal imaging

19.30 Conference dinner & folk music

Sunday 1st June

0900 – 13.00
X – XI Clinical applications & Future trends

14.00 Krakow sightseeing

An exhibition of equipment and related subjects will be held throughout the conference. Interested companies should contact Prof. Jung without delay. **ajung@cskwam.mil.pl**

ABSTRACT DEADLINE FEBRUARY 1st 2003

Abstract form in Thermology International (page 173) or conference website
thermo.cskwam.mil.pl/krakow2003/index.htm

REGISTRATION FEE

before Feb.1st 350 USD/ 350Euros

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Make sure that your name is shown on the documentation and registration form.

Registration form from: **ajung@cskwam.mil.pl** in Thermology International (page 174) or website.
thermo.cskwam.mil.pl/krakow2003/index.htm

Accommodation

The Conference Hotel is Campanile Krakow in the Old City and close to the Congress Centre
Sw.Tomasza 34 Str
Single room 75USD
Double 85USD (incl. breakfast)

13TH THERMO in Budapest

The Scientific Society of Measurement, Automation and Informatics (MATE) has the honour to invite you to the **13th International Conference on Thermal Engineering and Thermogrammetry (THERMO)**

from the 18th to 20th of June, 2003 in the OSSKI Center (Törley Palace), Budapest, XXII. (Budafok), Anna u. 5.

The Conference Organizers

Branch of Thermal Engineering and Thermogrammetry (TE and TGM)

Hungarian Society of Thermology (HST) at MATE,

European Association of Thermology (EAT),

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Dr. S. Kakaç, University of Miami, Coral Gables, USA

Dr. L.I. Kiss, University of Québec in Chicoutimi, Canada

Dr. G. J. Köteles, OSSKI, Director, Budapest, Hungary (HST)

Dr. M. Groll, IKE- University of Stuttgart, Stuttgart, Germany

Dr.T.-M. Liou, National Tsing Hua Univ., Hsinchu, Taiwan, Rep. of China

Dr. X. Maldague, University Laval, Quebec city, Canada (QIRT)

Dr. S. Mochizuki, Tokyo Univ. of Agriculture and Techn., Tokyo, Japan

Dr. T. Kapros, TÜKI Rt., Miskolc, Hungary

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Dr. M. Osztheimer, VEIKI Rt., Budapest, Hungary

Dr. E. Hahne, University of Stuttgart, Stuttgart, Germany

Dr. S. Švaic, FSB, University of Zagreb, Zagreb, Croatia (QIRT)

Dr. W. -J. Yang, University of Michigan, Ann Arbor, USA

Dr. B. Wiecek, Technical University of Lodz, Lodz, Poland (QIRT)

About the Conference

Since 1977 a successful series of Symposia has been organised by our Society every year. At the beginning these events were named "Symposium on Thermogrammetry" after a newly developed branch of thermal mapping methods which played a significant role in the program. As the scope of the symposia widened in 1982 they received the new name "Symposium on thermo-technical measurements".

Due to the broad and increasing interest shown by the international thermal engineering and medical communities, in 1987 it became known as the International Conference on Thermal Engineering and Thermogrammetry (THERMO). This conference is a series of biennial meetings. The Conference is intended to be an event worthy of the attention of all engineers, scientists, physicians and researchers who are involved in the solution of thermal or energy related problems, as well as in the applications of thermal imaging.

Objectives

The developments of measurement theory and technologies help the energy- conscious design of thermal engineering equipment and processes, it also improves understanding of thermal phenomena in living organisms.

The Conference will cover topics both the field of theory and application including new measurement concepts; transducer techniques; thermal mapping; contact, optical and IR imaging; biomedical and biotechnological applications; thermal informatics, automatic methods and systems for industrial energy management and process control; heat loss detection and analysis; heat and mass transfer; utilization of alternative energy; thermophysical properties and the common practice of thermal engineering.

This Conference will provide the latest information on the above topics together with a good opportunity for personal discussion among experts in the fields of energy conservation, control of energy release and loss, protection of human environment, medical and veterinary applications, remote control through infrared sensors.

Main Topics

The structure of the sessions will be fixed after receiving the papers, but the topics will cover the following fields:

General thermal engineering; theory of measurements; thermal informatics, thermo-CAD and its applications; industrial energy management and process control systems; practice of thermal engineering; infra-red imaging science & technology: thermogrammetry, micro- and nano-scale thermal phenomena and sensing techniques, thermal defects, applied thermo- optics; thermophysical properties; heat and mass transfer; cooling of electronic components; heat exchangers; combustion; thermophysics of the environment; building services; environmental aspects of energy use; thermo-ergonomy and thermo-psychology; thermo diagnostics; system analysis in thermo-biology; IR-imaging in biomedical and bio-engineering applications; remote sensing through IR-imaging, multidisciplinary topics.

Technical Issues

The language of conference and abstracts is English. Both oral presentation of papers and a poster session will be organized. The preliminary programme (until June, 2002) includes more than 30 papers from 21 countries (Algeria, Canada, Croatia, Czech Republic, France, Germany, Hungary, India, Iran, Italy, Japan, Jordan, Korea, Poland, Portugal, Romania, Russia, Slovakia, Turkey, Ukraine, USA).

The duration of each presentation will be limited to 15 minutes and additional time for discussion will also be provided. The English translation of lectures not read in English should be submitted at the registration desk on the spot. LCD projector and computer with Windows OS for Microsoft Power Point format presentations is available. (Please note that using your own computer is not allowed.) Those intending to attend the conference are kindly invited to send a registration form to the address listed later, under the heading 'INFORMATION'.

Exhibition

During the conference an exhibition of scientific and industrial instrumentation will be organised. Exhibitors from the field of temperature measurement and control, thermal properties, IR-imaging, anemometry, industrial energy control, heat loss detection equipment etc. are welcomed.

Venue

The conference is hosted by the OSSKI Center (Törley Palace, Budapest, XXII. (Budafok), Anna u. 5.) located in the vicinity of the famous Budafok wine cellars. More information about the conference place and hotel accommodation will be sent after the arrival of the Registration Form.

Call for Papers

The photocopy-ready papers of six A4 format pages to be presented on the conference are to be submitted before 15 December, 2002. To assist the work of the Scientific Committee the authors are kindly requested to point out the aim, method and results of their work.

Notification of the acceptance will be forwarded to the authors until 28 February, 2003. The abstract of all accepted papers will be included the Proceedings to be presented to the participants at the Conference.

Information

Application Forms and papers should be sent to:

Dr.Imre BENKÕ, MATE Secretariat, House of Technology, III.318.,

H-1372 Budapest, POB. 451., Hungary.

Fax: +361-353-1406 Phone: +361-332-9571.

E-mail:benko@hp.osski.hu

For any further information please contact the following address:

Dr. Imre BENKÕ, Budapest University of Technology and Economics (BME), Department of Energy Engineering (DoEE), H-1111 Budapest, Mûegyetem rkp. 7. D.208., Hungary.

Office phone: +361-463-2183.
DoEE Phone/fax: +361-463-3273 or -310-0999.

Home Phone/fax: +361-310-0999

E-mail: benko@eta.enrg.bme.hu and please send a copy to: benko@hp.osski.hu

or visit
http/www.osski.hu/rendezv/thermo13.htm.

and for 12THERMO(2001)
http/www.osski.hu/rendezv/thermo.htm.

Typing instructions

for Papers of the 13th International THERMO Conference

The papers should comply with the following structure (Font style and size of individual items are indicated in brackets. The font type should be Univers/ Arial/ Helvetica.)

Deadline: Papers should arrive before
15 December, 2002.

Title of the paper (Bold, 18 points, directly at top of page)

[Please leave two blank lines here]

Author's name (degree, title) (Bold capitals, 12 points, aligned to right) (The name of the co-author who presents the paper should be underlined)

Author's affiliation (institution) (Italics, 12 points)

Mailing address (city, street address, country, ZIP code)(normal, 12 points)

[Please leave three blank lines here]

SUMMARY (Bold, 10 points)

A short summary of about six lines. (Normal, 10 points)

[Please leave three blank lines here]

Text of the paper starts here. The paper should provide the following information: purpose of the study, the methods used, summary of the results and conclusions. Authors are requested to emphasize the novelties in their work. (Normal, 12 points. Subheadings should be in bold.)

The text should be typed on A4 paper and completely fill the 16.5x25cm typing area (top/bottom margins: 2/2.8 cm, left/right margins: 2.5/2 cm).

The papers should not exceed six pages. They must be typed in English, with single line spacing. One blank line shoud be left between paragraphs. For headings and subheadings international numbering should be used (e.g. 1., 1.1., 1.1.1.). Paragraphs must be indented with three spaces. Hand-written special symbols are to be drawn in black ink.

The contact details should appear at the end of the paper according to the sample below:

Contact details: Prof. Dr. Imre BENKÕ,

Budapest University of Technology and Economics (BME), Faculty of Mechanical Engineering, Department of Energy Engineering (DoEE), H-1521 Budapest, Mûegyetem rkp. 7/D. 208. Hungary,
DoEE Phone/Fax: +361-463-3273
or 361-310-0999,
Home Phone/Fax: +361-310-0999
e-mail: benko@eta.enrg.bme.hu and please send a copy to benko@hp.osski.hu, too.

Pagination should only appear on the reverse side of the page in blue crayon.

Please note that in printing process of the papers are photocopied to A4 size. Therefore papers must be photocopy ready.

Please DO NOT FOLD THE MANUSCRIPT ! It must be mailed in manila envelope with cardboard backing. Papers not complying with the above will not be accepted.

4th Instructional Course on Thermal Imaging in Medicine

After three successful courses on Thermal Imaging in Medicine in 2001and 2002, a further course will held on theory and practice of Infra red Imaging in Medicine. The 4th Short Course will be held on April 9-11, 2003 at the School of Computing of the University of Glamorgan in Pontypridd, Wales, UK. Prof K Ammer, Prof F Ring and Dr P Plassmann will lecture on the theoretical and historical basis of thermal imaging in medicine, clinical applications and future developments of thermal imaging in medicine. A supervised practical session is included which focuses on the capture and analysis of images.

Registration Fee is £300. Cheques should be made payable to The University of Glamorgan. The Fee includes lunch and refreshment breaks, the hardback book -The Thermal image In Medicine and Biology, and a CD of Archived IR Imaging in Medicine publications,

The course is recognized by The University and certificates will be issued to all who complete the short course.

Further information can be obtained from
Prof Francis Ring
(01443 483717 , e-mail efring@glam.ac.uk) or

Dr Peter Plassmann
(01443 483486, e-mail pplassma@glam.ac.uk)

School of Computing, University of Glamorgan, Pontypridd, CF37 1DL

Detecting Breast Cancer with A New Algorithm and a Multi-spectral Infra-Red Imaging System (Press Release, Office of Naval Research, 800 N. Quincy St., Arlington, VA 22217-5660 http://www.onr.navy.mil)

What does remote sensing for camouflaged enemy ground vehicles have to do with breast cancer diagnosis? By next year, perhaps plenty. A smart sensor fusion algorithm modeled on the human visual/brain “unsupervised“ learning System and a 200 channel hyperspectral remote sensing capability have been developed by the Office of Naval Research for use as a passive electro-optical, infra-red ground surveillance system. The same method has now shown success in detecting the heat radiated by abnormally reproducing breast cancer cells.

Hyperspectral sensors sweep up enormous quantities of data, but their usefulness has been limited by our ability to pull the important information out of that clutter. The algorithm that processes the data is the important factor. Last year the Under Secretary of Defense for Science and Technology asked ONR to look at the potential usage of remote sensing to improve breast cancer diagnosis. Dr. Harold Szu and Mr. James Buss‘ single-pixel unsupervised classification algorithm, based on the Lagrange Constraint Neural Network (LCNN) and multiple spectral data per pixel initially designed to increase the effectiveness of surveillance systems, now promises to enhance the sensitivity and accuracy of breast cancer testing.

Abnormally reproducing cells demand greater nutrition through increased blood supply, thus generating higher concentrations of heat in specific areas. Applying their algorithm, Dr. Harold Szu and Mr. James Buss are able to classify the infrared heat distribution given off by these cells.

A truly unsupervised algorithm per pixel must be based on the information derived directly form spectral data alone. In order to reveal the hidden spectral features contained in a single pixel image data vector X=[A]S, one has to invert the matrix without knowing both the breast-medium heat-transfer matrix (MTF) [A] and the heat source 5 which both vary from pixel to pixel. While ONR‘s spave-variant imaging algorithm following the spectral data vector analysis and the physics constraints of thermodynamics free energy minimization has achieved sub-pixel accuracy, other statistical Independent Component Analyses (ICA) methodologies suffer pixel-averaging blurring effect. This is because the average over neighborhood pixels must implicitly assume an identical MTF [A] for the space-invariant imaging. This would be true only in cases of a large tumor requiring no more automatic target detection.

Similar to a pair of human eyes, a pair of cameras at different infrared wavelengths —Medium wavelength IR (3-5 µm) camera and Long wave- length IR (8-12µm) camera. Both have about 10 milli Kelvin degrees in the minimum resolvable temperature difference (MRTD) — transcribes this thermal diffusion process into two images, which are then filtered for shared signals while disagreement noise is minimized. Through this process, last February Szu and Buss and their team detected early stage ductal carcinoma in situ (DCIS) in a test patient using a double-blind procedure (see images here:
http://www.onr.navy.mil/ops/media/download.htm)

“This multispectral, sub-pixel super-resolution is potentially more accurate by an order of magnitude,“ states Dr. Szu, “lt offers a passive, inexpensive, non-intrusive, convenient means of screening pre-cancer patients without radiation hazard, and may potentially detect in situ carcinomas long before a mammogram might detect them.“

Thermal breast scanning has been employed for a number of years, especially in Europe and Asia, but its use has been limited to a single infra-red band, using a single camera. The application of the “unsupervised“ classification algorithm may offer an unbiased, more sensitive, accurate, and generally more effective way to track the development of breast cancer, without demanding the variables of a long wait in a cold room, increasing the variability inaccuracy in thermal detection and causing patient discomfort.

The success of the initial double-blind experiment substantiates the promising application for the use of multispectral imaging in improving the early detection process for breast cancer and possibly other dermal carcinomas. A provisional patent application has been filed. Follow-on research and clinical studies are being planned through the use of Cooperative Research and Development Agreements (CRADA). A web-based database of medical images (MedATR) is being developed by Advanced Concepts Analysis Inc., of Falls Church, VA, hosted on the Air Force Virtual Distributed Laboratory secure web site (VDL).

For more information on this story, please call:
GaiI Cleere, 703-6964987, or
email cIeereg @onr.navy.mi1) or
Jennifer Huergo, 703-696-0950, or
email huergoj@onr.navy.mi1

UKTA Medical Section News

The Medical Section newsletter keeps members up to date with medical infrared issues in the UK. It brings you news of meetings, member profiles, and reports on the use of medical infrared thermography from around the UK. Please send any items to the editor, Kevin Howell. We need your news to fill this space in future issues !
The next newsletter will be published in December, with the deadline for copy being 30th November.
infrared_thermography@hotmail.com

"Medical Infrared Thermography" meeting report from the Royal Free Hospital

This year's UK Medical Infrared Thermography meeting on 18th May attracted some of the leading experts in the field of thermal imaging. Speakers came from across the UK, and also from Austria, Germany, the Czech Republic and the USA.

Prof. Francis Ring (University of Glamorgan School of Computing) gave the opening keynote address on the history of medical thermography. He described how Sir William Herschel's discovery of infrared radiation in 1800, and Carl Wunderlich's groundbreaking thesis on medical thermometry in 1871, were the initial steps towards thermography performed with today's state-of-the-art focal plane array thermal imagers.

Dr. Graham Machin (National Physical Laboratory, Teddington) gave the inaugural Brian Chu Memorial Presentation. Brian worked on temperature standards at NPL for 19 years, and was developing a blackbody calibration source for medical thermography at NPL prior to his untimely death in April 2002. Graham described the importance of regular calibration of medical thermal imagers, and the challenge of demonstrating that temperature measurements are traceable to the International Temperature Scale of 1990 (ITS-90).

Dr.Paul Campbell (Ninewells Hospital, Dundee) spoke about the use of thermography in surgery, which is being pioneered by Prof. Sir Alfred Cuschieri in the Department of Surgery and Molecular Oncology at Ninewells. Paul presented some thermographic observations of a heat-activated shape memory alloy suture staple. He explained how thermography has helped in the optimisation of the staple design by visualising the heat flow through the alloy when it is heated resistively to achieve closure. Paul next explained how dynamic thermography is also used at Ninewells to determine the degree of thermal spread from surgical instruments in energised surgery. This work will be important in optimising energised surgical techniques to ensure that there is minimal collateral thermal damage during such procedures.

Prof. James Levine (The Mayo Clinic, MN, USA) gave an informative and highly entertaining presentation of his research into the detection of deception using thermography of the face. This work was first published in Nature at the end of last year, and attracted a great deal of media interest on both sides of the Atlantic. Jim explained how the ability to reliably detect deceit would be of obvious benefit to national security, but pointed out that deception and harmful intent are not the same thing. He then presented his group's findings, which show that warming of the area around the eyes is an indicator of deceit comparable in reliability to a US Department of Defense polygraph test. The potential benefit of thermography over the polygraph is that infrared imaging could in be employed in principle without the subject's knowledge.

Kevin Howell (Royal Free Hospital, London) closed the meeting by thanking the participants and sponsors, and presenting a brief review of the state of medical infrared thermography world wide. He explained that the next European infrared thermography meeting was due to take place in Krakow in June 2003. Plans were also being made to publish the proceedings of the London meeting on CD ROM this summer, and establish a database of UK researchers with expertise in medical thermography. Kevin also brought a number of resources for thermographers to the audience's attention. The UK Thermography Association (UKTA) Medical Section is the national organisation promoting medical infrared imaging, and publishes a regular newsletter. "Thermology International" is the journal of medical infrared imaging, published by Prof. Kurt Ammer at the Ludig Boltzmann Institute in Vienna. A searchable archive of thermography papers in .pdf format is available for purchase from Prof. Ring at the University of Glamorgan.

The meeting was supported by the Engineering and Physical Sciences Research Council Grant GR/S00026/01, and sponsored by Flir Systems and Moor Instruments.

"Thermology International" for UKTA Medical Section members

"Thermology International" is the Embase-listed journal of medical thermography. It is the official scientific journal of the UKTA Medical Section, and a large number of other national and international medical thermographic associations world-wide. UKTA Medical Section members can subscribe to "Thermology International" at a discounted rate.

The UKTA committee is keen to encourage increased uptake of the journal. To further this aim we have reached a new agreement with the editor, Prof. Ammer, which means UKTA will distribute the journal to members in the UK and collect subscriptions.

To subscribe to "Thermology International" please complete the form enclosed and send a cheque for £30 to Kevin Howell at the Rheumatology Department, Royal Free Hospital, Pond Street, London. NW3 2QG. Cheques should be made payable to "UKTA". The fee is the sterling equivalent of the 32 Euro subscription fee, plus a charge for banking and mailing fees. Henceforth, copies of the journal will be forwarded to UK subscribers by Kevin Howell at the Royal Free Hospital.

UK members of the "Thermology International" editorial board will continue to receive copies of the journal direct from Vienna.

If you have any questions about this new arrangement, please contact Kevin Howell by e-mail at infrared_thermography@ hotmail.com

Becoming a "Medical Section" member

A number of general members of UKTA have expressed an interest in joining the Medical Section, and have asked if it is necessary to pay the subscription fee quoted on our Medical Section subscription form in addition to the general membership fee. In fact, any full UKTA member can join the Medical Section at no additional cost. Just let Kevin Howell know, and he will be pleased to add you to the "Medical Section" membership list. This will give you the right to receive the dedicated medical newsletter, and to subscribe at the reduced rate to "Thermology International."

The Medical Section subscription rate exists solely for medical users of thermography who do not require full general membership of UKTA or use of its services to industry. Consequently, these "Medical Section only" members have reduced UKTA membership privileges.

New Member Profile

The UKTA Medical Section is very pleased to welcome Dr. Paul Campbell as our latest member. Below is his profile, which will also appear in the forthcoming database of medical thermographic expertise to be issued on CD-ROM along with the proceedings of the London meeting. If you attended the London meeting, or are actively involved in medical infrared thermography in the UK, Paul needs your profile for the database (in a format similar to his profile below) right now! Please send all copy to Paul's address at Ninewells Hospital. We intend to include profiles of both new and established Medical Section members in future newsletters, so any profiles submitted will fill a dual purpose, and will be most gratefully received by the editor!

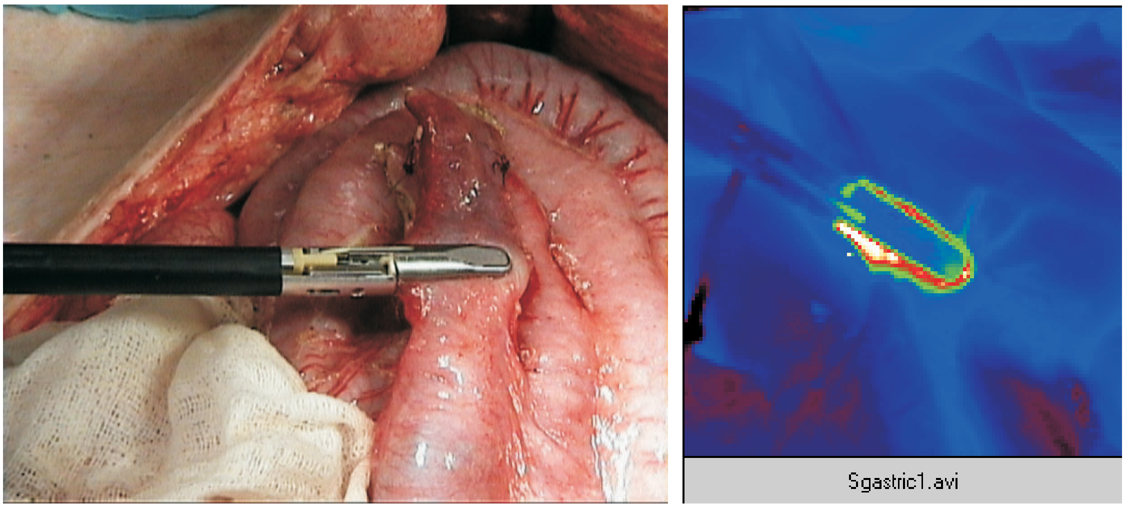
Dr Paul Campbell

Department of Surgery and Molecular Oncology, Ninewells Hospital, Dundee University, Dundee DD1 9SY Scotland.

BACKGROUND

Paul is a graduate of London University (BSc Physics 1990) and Queen's University Belfast (PhD Experimental Physics 1994). He gained research experience in the field of infrared modelling whilst a Higher Scientific Officer with the Defence Research Agency at Farnborough, and has held experimentally based postdoctoral positions at the Universities of Bath and Belfast. He moved to his present position as Senior Research Fellow with the Surgical Technology Group at Dundee in May 2000. In the past year he has conducted a major thermographic study in collaboration with the renowned keyhole surgeon, Sir Alfred Cuschieri, to assess the use of infrared imaging as an adjunct to energised surgery. Dr Campbell has held grants from *The Nuffield Foundation, EPSRC, The Royal Society, DTI, and The Wellcome Trust* in the past. He was the co-organiser of the 'UK Symposium on Medical Thermal Imaging and Related Techniques' which took place at the Royal Free Hospital earlier in the summer.

Figure 1.
(left) A laparoscopic RF bipolar vessel sealing instrument imaged in the normal visible range of the electromagnetic spectrum. (right) The same instrument imaged in the infrared during activation. Note the limited range of thermal spread beyond the instrument periphery. Also important in this context is the fact that the instrument head does not heat up appreciably, and therefore the possibility for accidental thermal damage upon removal of the instrument is also reduced.



APPLICATION
Thermography during energised surgery

KEYWORDS: Dynamic thermography; cancer; energy based surgery; endoscopy; computational modelling; thermal collateral damage; black body calibration sources; thermal physics

Energised surgical instruments are commonplace and may rely on ultrasonic; RF bipolar (and monopolar); or laser based energy sources for operative purposes. A typical surgical goal might be to seal or dissect vessel/tissues quickly, and such energised approaches usually work by heating the target structure into a distinct temperature regime to achieve an alteration in the physical properties of tissue. Under such circumstances, it is usually found that tissue outside the target region of interest is also affected by the heating procedure, leading to collateral damage. We have begun an extensive study of collateral damage and mechanisms whereby it can be reduced or indeed eliminated during energised surgery. Monitoring instrument activation using thermal imaging has proved to be a powerful adjunct to surgery and allows: power levels to be optimised *in situ*, as well as facilitating observation of relevant clinical parameters such as the level of blood perfusion and also the direct assessment of seal integrity. We will enhance our activity in this area in the near future through the development of a versatile dual channel infrared endoscope.

contact details:
tel: 01382 496490, fax:01382 496361
e:p.a.campbell@dundee.ac.uk

Thermography for the assessment of osteoarthritis

For the first time since years a short paper was published in the Annals of Rheumatic Diseases discussing the advantages of thermal images in joint disorders. A group from Japan (1) reported a correlation between surface temperature over the knee joint with narrowing of the joint space of the tibiofemoral joints. The authors found also a correlation between the level of temperature and the size of osteophytes. Some significant correlations between temperature and clinical symptoms were also reported, although the correlation coefficients were less than 0.7 in all comparisons, being best with a figure of -0.65 in the comparison of knee flexion and temperature. An astonishing relationship between knee temperature and the ability of walking was described, which showed higher temperatures on the medial and especially on the lateral tibiofemoral joint in patients without restrictions in walking than in subjects with impaired walking ability.

The authors tried to control the inter-individual variations of skin temperature by subtracting the mean temperature of the patella from the temperature of the medial or lateral knee respectively. The findings of this study showed higher temperatures over the lateral than over the medial part of the knee. Engel (2) described in healthy subjects higher temperatures at the medial part of the knee. Japanese subjects without any impairment in standing or walking presented with two or three-fold temperatures at the lateral knee than at the medial knee. Differences in body structures found in Japanese and in Europeans might contribute to these different thermographic findings.

References

1. Warashina H, Hasegawa Y, Tsuchiya H, Kitamura S, Yamauchi KI, Torii Y, Kawasaki M, Sakano S. Clinical, radiographic, and thermographic assessment of osteoarthritis in the knee joint. Ann Rheum Dis 2002; 61: 852-854

2. Engel J-M. Quantitative Thermographie des Kniegelenks. Z.Rheumatol 1978; 37: 242-253

Veranstaltungen (MEETINGS)

November 7-10, 2002

Annual Meeting of the American Academy of Thermology in Orlando

Venue:
Marriott Residence Inn.

Seaworld International Center,

11000 Westwood Boulevard,

Orlando, Florida 32821.

Phone: 407-313-3600, Fax; 407-313-3611.
www.residenceinnseaworld.com

Information:

Dr.Hooshmand at hoosh@prodigy.net

or Dr.Goldberg at JerryGol@aol.com

December 4-8, 2002

EMBEC´02 , 2nd European Medical & Biological Engineering Conference in Vienna, Austria

Venue: Vienna International Congress Centre

Special Session:
Developments in Infrared Thermal Imaging, organised by
Prof Dr.EFJ Ring & Prof.DDr K.Ammer

Information about EMBEC:
Prof. Dr. Helmut Hutten

Institute for Biomedical Engineering
University of Technology
A-8010 Graz (Austria), Inffeldgasse 18
tel: ++43-316-873-7390 fax: ++43-316-46 53 48
email: hutten@ibmt.tu-graz.ac.at

Information about the infrared session:

Prof Dr Francis Ring, email:efring@glam.ac.uk
Prof DDr Kurt Ammer.
Email:kammer1950@aol.com

May 30th – June 1st, 2003

9th European Congress of Medical Thermology in Krakow, Poland

Venue: Cultural Institute, Kraków,
Zyblikiewicza 1 Str

Abstract deadline: February 1st 2003

Registration fee

Before February 1st, 2003 350 USD
After February 1st, 2003 450 USD

The payment has to be made to

10201156-202693-270-1

POLSKIE TOWARZYSTWO DIAGNOSTYKI TERMOGRAFICZNEJ W MEDYCYNIE

Hotel accommodation

A convenient hotel, Campanile, is located 100 meters from the conference hall in Sw. Tomasza 34 Str.

Single room: 75 USD (breakfast included)
Double room: 85 USD (breakfast included)

Deadline for hotel reservation April 15th 2003
Reservation e-mail: ajung@cskwam.mil.pl

June 18.-20, 2003

13th International Conference on Thermal Engineering and Thermogrammetry (THERMO)

in the OSSKI Center (Törley Palace).
Budapest, XXII. (Budafok), Anna u. 5.

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

Secretary: I. Kovacsics, Msc.

EGI-Contracting/Engineering Co. Ltd., Budapest, Hungary (HST, TE & TGM)

Information: Dr.Imre BENKÕ
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BME Fax: +361-463-1110
E-mail: benko@eta.enrg.bme.hu

Combined Conferences

9^{th} European Congress of Medical Thermology

6^{th}National Congress of the Polish Association of Thermology

16^{th} Thermological Symposium of the Austrian Society of Thermology

Kraków / Poland – May 30^{th} – June 1^{st}, 2003

REGISTRATION AND HOTEL ACCOMMODATION FORM

PARTICIPANT

First Name ....

Family Name ....

Address ....

ZIP Code ....

City ....

Country ....

Phone ....

Fax .... E – mail ....

REGISTRATION FEE

Paid until	February1^{st}, 2003	350 USD
Paid after	February1^{st}, 2003	450 USD

HOTEL ACCOMODATION

I would like to make the following reservation in Campanile Hotel:

....	Single room	75 USD
....	Double room	85 USD

Deadline for hotel reservation – April 15^{th}, 2003

Date of arrival .... Date of departure .... no. ....of nights

PAYMENT

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POLSKIE TOWARZYSTWO DIAGNOSTYKI

TERMOGRAFICZNEJ W MEDYCYNIE

Signature .... Date.......................

Return to:
Organising Comittee:
Pediatric and Nephrology Clinic MSM
Szaserów Str 128 00 909 Warsaw 60, POLAND
Fax (48 – 22) 6816763 E – mail ajung@cskwam.mil.pl

Combined Conferences

9th European Congress of Medical Thermology

6th National Congress of the Polish Association of Thermology

16th Thermological Symposium of the Austrian Society of Thermology

Kraków / Poland – May 30th – June 1st, 2003

Last Name...First Name.. Title ....

Institution ....

Street ....

ZIP Code ....City..Country ....

Phone.. Fax .... E – mail..

Title Autors Abstract

Return this form not later than February 1st, 2003 to: Prof. Anna Jung

Pediatric and Nephrology Clinic MSM
Szaserów Str 128 00 909 Warsaw 60, POLAND
Fax (48 – 22) 6816763 E – mail ajung@cskwam.mil.pl

return to TOC

Thermology international

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Österreichische Gesellschaft für Thermologie

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Österreich

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Payment should be sent (without any charges for the European Association of Thermology) to the following bank account:Bank Austria, Vienna, Austria, bank number:20151, account number: 965023054

Thermology international

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Österreichische Gesellschaft für Thermologie

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