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Thermal Symmetry of Human Skin Temperature Distribution

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The study of skin temperature has been dramatically increased since infra red thermal imaging was introduced into medicine 40 years ago, Earlier work, notably by Hardy, established in 1934 that the skin is a highly efficient radiator with an emissivity of 0.98, irrespective of colour or pigmentation (1). Many of the early studies with this technique focused on the diagnosis of breast cancer. The role of the vasculature in the thermal patterns observed from imaging the human body became obvious. Vascular diseases, deep vein thrombosis, Raynaud's phenomenon. ischaemic disease etc. are of interest using thermal imaging since high perfusion areas are warm to hot and low perfusion result in loclised decrease in skin temperature.

Some 20 years ago, investigators became interested in the neurological control of skin perfusion. Neurological injuries resulting in cold extremities had been often reported in the literature, and attention turned to the optimal condtions required to image these effects. Inflammatory conditions such as arthritis and breast diseases were commonly examined at a cool 18 - 20°C ambient. lt was recognised that performing a cold stress test in the extremeties, to measure response to a thermal challange at a cool ambient could result in vasoconstriction. The same test performed at 22-24°C provoked a more measurable reaction, including reactive hyperaemia in some healthy subjects depending on the temperature of the water bath used. At room temnperatures above 24°C subjects in Europe were known to commence sweating, which is generally detrimental to the thermal image quality (2). (Modern high resolution imagers can resolve sweat pore secretion, which can be of clinical use).

The application of infra-red imaging to neurological injury or disease led to renewed interest in the question of skin temperature distribution in normal subjects. Uematsu and other investigators published data on the thermal symmetry of the human body as revealed by thermal imaging. In 1985 Uematsu reported on "Thermographic imaging of cutaneous sensory segment in patients with peripheral nerve injury "- Skin temperature stability between sides of the body (3). In this paper he described a mapping protocol for 23 regions of the body surface from the forehead to the foot. Contra-lateral temperature differences ranged from 0.11°C (SD 0.085) at the anterior thigh to 0,3°C (SD 0.201) on the anterior foot. The average thermal difference from each side of the extremities was 0,2°C (SD 0.073). These data were reproduced in Thermology in 1985, which is now on the archive CD ROM of Thermology papers. The subject sample was 32 controls compared with 24 patients with peripheral nerve trauma. A more detailed report appeared in 1988 by Uematsu, Edwin et al. titled "Quantification of Thermal Asymmetry - Normal values and reproducibility" (4).

In 1986 Goodman, Murphy et. al. published the results of their study on 31 clinically normal males and females aged 20-50 years (5). They studied the normal distribution of human surface temperature of the back and extremities. They also examined for any influence of age, sex, percent body fat and somatotype on the thermal patterns, Using a grid system they were able to determine the degree of symmetry with different sizes of regions of interest. They did not find any connection between the right handed dominance and thermal symmetry in their subjects, Their data showed that right-left skin surface comparison is possible using areas greater or equal to 5.0 x 5,0 cm^2 on the back and 2.5cm extent x the half width along an extremity. They also found that thermographic symmetry was stable across a one or two week interval. Region to region difference values yielded significant correlation coefficients ranging from +0.85 to 0.84 (p< 0.01). No individual region varied on repeat more than 0.2°C. They confirmed that extremities reveal more thermal variability than back regions, but that symmetry bore no correlation with age, sex, body compostion or build. Since Iocal structural and vascular differences determine skin temperature patterns it is clear that abnormalities following trauma of some kind will change the local temperature, which may lead to asymmetry. Chronic lesions following accidents or arthritis may leave a disturbed vascular pattern for many years. The results of this study are important because they quantified the normal distribution in a well characterised population. They report that "using high cut-off limits of this normal distribution rnake it very likely that thermal asymmetry exceeding the published values represents a diseased or injured state. In soft tissue injuries there are few diagnostic gold standards. Use of a high cut off such as 99 percentile for high speciflcity may be appropriate to diagnose abnormality'.

A study in Bath to evaluate low back pain in 120 patients was reported in 1986 (6). A group of 121 males and females (96M & 55 F) with no history of back pain or arthritis were also examined. Thermal symmetry of the lower limbs was documented as shown in Table 1. Exclusions were made in some 10%. of this group where vascular abnormalities such as varicose veins were visible on the monochrome thermogram.

From the above figures it may be generally concluded that temperature differences of less than 0.4°C from side to side may be considered to be within the normal range. All these data are of course only valid after adequate patient preparation with the sites exposed to a constant ambient temperature using a stable and calibrated thermal imaging system (7,8).

Another publication by Uematsu on the Cerebral Cortex in the control of skin temperature in man included a report from the Neurological Society of London in 1889 (9). Doctor Hale White delivered a paper on the variations in surface temperature of the two sides of the body in compression of the brain. A Professor Horsley also reportedt on a seven year study of temperature asymmetry following brain injury. Others present joined the debate, and it was concluded that they agreed on the facts and their scientific importance, but that much clinical and experimental work must yet be done before certainty of interpretation could be reached. One hundred und ten years later we have the benefit of well developed technology with which we can study the syrmmetry of skin temperature in man. The American Medical Association council report on thermography in 1987 confirmed that thermal symmetry of the human body surface was establishled , and reviewed the clinical applications where the determination of asymmetry had been applied (10) The report listed some particular applications in

Table 1

Site	mean temp. diff.°C	Standard deviation
Anterior thigh	0.23	0.19
Posterior thigh	0.17	0.16
Lateral thigh	0.24	0.17
Anterior lower leg	0.26	0.17
Posterlor lower leg	0.23	0.18
Lateral lower leg	0.28	0.17
Dorsal foot	0.35	0.24

neurological and musculoskeletal conditions i.e.

1.When the results of anatomic tests are unclear or contradictory, the additional information provided by an abnormal thermogram may suggest a diagnosis that ultimately proves correct.

2. Thermography can detect sensory/ autonomic nerve dysfunction. In those cases where it is felt necessary to proceed beyond conservative therapy, thermal imaging has high sensitivity and is an effective screening method for spinal nerve root fiber and distal peripheral nerve fiber pathology.

3.Thermography is a physiological test that complements anatomical and structural observations made with modern radiological techniques (x-ray, myelography, CT scan) and magnetic resonance imaging.

They concluded that “thermography may be regarded as one piece of information that must be ‘integrated with other available information in the physician’s decision rnaking process.’

An editorial in Thermology 1988 included the following:

“Present day thermographic technology enables us to perceive and quantize fine temperature differences, and map them with exquisite precision, In contrast, Hippocrates had only his hand, an insensitive sensor indeed, easily confused by ambient influences, and able to discriminate 2°C at best. Today, in our laboratories, thermographic sensors reliably discriminate 0.1 °C, giving us access to thermal data that formerly was hidden.

We may accept, as a given, that cutaneous temperature symmetry is the rule in normal asymptomatic persons.

We may accept as given, that significant cutaneous temperature asymmetry is an abnormality that should motivate the astute physician to searchi for the underlying cause, in much the same way he would initiate a diagnostic workup in a patient with a fever of unknown origin. Abnormalities of body ternperature, whether core temperature or skin temperature, are often the first alert to the presence of disease’.

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The determination of regions of interest on infrared images of the hands of patients suffering from carpal tunnel syndrome

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Ludwig Boltzmann Research Institute for Physical Diagnostics (Director: O.Rathkolb, M.D), Vienna, Austria

Summary

We have investigated the question whether the temperature of the index finger is correlated to the temperature of the sensory distribution of the median nerve on the dorsum of the hand.

The infgrared thermograms of 52 hands, were examined before and up to 5 times after a moderate cold stress test (immersion of the hands with plastic gloves for 1 minute in water of 20°C). Regions of interest were defined on the dorsum of each hand. The distribution of sensory fibers of the median nerve (ulnar site of the thumb, 2nd and 3rd finger and die radial site of the 4th finger from the finger tips to just above the metacarpophalangeal joints) and of the ulnar nerve (ulnar site of the 4th and total of 5th finger from the fingertips to the wrist). Regions on the index and the little finger, from the finger tips to just above the metacarpophalangeal joints were also defined. The mean temperature of these 4 regions of interest was recorded. The differences of finger temperature (df = temperature of the index (if) minus temperature of the little finger (lf)) and of nerve areas (d=temperature of the median nerve area (mt) minus the temperature of the ulnar nerve area (ut)) were calculated. Temperature values and temperature differences were correlated at each measurement time. Finally, the difference of d minus df was calculated and all results were cumulated into one file.

Electrophysiologic testing of the median nerve was performed in all the hands studied. 16 hands presented with a distal latency longer than 6.0msec and in 16 hands the distal latency was in the range of 4.4 to 6msec. The remaining 20 hands showed normal values for the distal latency.

Prior to the cold stress test the mean temperature of the index was 0,.06 degrees higher than the mean temperature of the median nerve area. At this time the little finger presented with a mean temperature of 31.93°C compared to 32.00°C for the ulnar nerve area. Correlation coefficients of 0.98 and 0.97 indicate that these values are almost identical.

For the cumulated file the difference of of d minus df was within a 95% confidence interval of -0,03 und 0,29 degrees.

We conclude from these data that the temperature of the index or the little finger is highly representive for the temperature of the sensory area of the median or ulnar nerve, respectively. Therefore, regions of interest over these fingers should be used instead areas over the sensory distribution of the median or ulnar nerve, because these areas may be difficult to define.

Key words: carpal tunnel syndrome, sensory area , thermography

Die Plazierung von Messarealen auf Thermogrammen von Patienten mit Karpaltunnelsyndrom

Wir haben versucht die Frage zu klären, inwieweit die Temperatur des Zeigefingers repräsentativ für die Temperatur des vom N.medianus innervierten Hautareals der Hand ist.

Dazu wurden die Thermogramme von 52 Händen analysiert, bei denen Aufnahmen vor und bis zu 5 mal nach einem definiertem Kältestresstest (1Minute lang mit Plastikhandschuhen in 20°C kaltes Wasser tauchen) angefertigt worden waren. Zu diesem Zweck wurden am Handrücken Messareale definert: Das sensible Medianusgebiet (Ulnarseite de 1.Fingers, 2. + 3.Finger + Radialseite des 4.Fingers, von den Fingerspitzen bis knapp oberhalb des MCP-Gelenkes reichend) und das sensible Ulnarisgebiet (Ulnarseitedes 4. Fingers und der gesamte 5.Finger, von den Fingerspitzen bis zum Handgelenk reichend) wurden markiert. Der Zeigefinger und der Kleinfinger, jeweils von der Spitze bis zum Metacarpophalangealgelenk, stellten die weiteren Messareale dar. Die mittlere Temperatur dieser 4 Regions of interest wurden aufgezeichnet. Differenzen zwischen den Fingertemperaturen (df =Zeigefingertemperatur, Zt, minus Kleinfingertemperatur, Kt) bzw die Differenz (d) zwischen Medianustemperatur (Mt) und Ulnaristemperatur (Ut) wurden gebildet. Die Absoluttemperaturen und die Temperaturdifferenzen wurden zu jedem Messzeitpunkt miteinander in Beziehung gesetzt. Schließlich wurde die Differenz von d minus df errechnet und sämtliche Messungen in eine Datei kumuliert.

An allen Händen wurde vor der thermographischen Untersuchung die distale Latenzzeit des N. medianus bestimmt. Dabei fanden sich 16 Hände mit einer distalen Latenz von mehr als 6,0 msec, bei 16 Händen lag die Latenz zwischen 4,4 und 6.0msec und bei den restlichen 20 Händen fand sich keine Latenzverlängerung. Vor dem Kältestresstest war der Mittelwert des Zeigefingers um 0,06 Grad höher als die Medianustemperatur. Der Mittelwert des Kleinfingers lag zu diesem Messzeitpunkt um 0,106 Grad über der Temperatur des Ulnarisgebietes. Diese praktisch identen Temperaturwerte spiegeln sich Korrelationskoeffizient von 0,986 für Medianus und Zeigefinger bzw 0,97 von Ulnaris und Kleinfinger wieder.

Der Unterschied von df minus d der kumulierten Datei über sämtliche Messungen zeigt ein 95% Vertrauensintervall zwischen -0,03 und 0,29 Grad. Wir schließen aus diesen Daten, daß die Zeigefinger bzw. Kleinfingertemperatur ausreichend genau die Hauttemperatur des Medianus- bzw. Ulnarisareals wiedergeben, sodass auf die aufwendige Definition des Innervationsgebietes als Messareal verzichtet werden kann.

Schlüsselwörter: Karpaltunnelsyndrome, sensibles Hautareal, Thermographie

Introduction

In thermographic investigations, the location of regions of interest on the hands of patients suffering from carpal tunnel syndrome has a significant effect on the results of thermographic investigations. As the sensory areas of the median nerve are different in distribution on the palm and on the dorsum of the hand (1) (figure 1), the definition and location of the regions of interest on the dorsum of the hand may be difficult. In an earlier study we have shown that temperature readings from an area over a single finger show a high degree of inter- and intra-investigator reliability (2). Another study on thermal imaging of patients with carpal tunnel syndrome suggested the index as a relevant placement of temperature measurements (3).

We used the results of a recent study (4) in patients with severe carpal tunnel syndrome to demonstrate that the temperature of the index or the little finger, show a high correlation with the respective temperature readings of the sensory area of the median or the ulnar nerve of the dorsum of the hands.

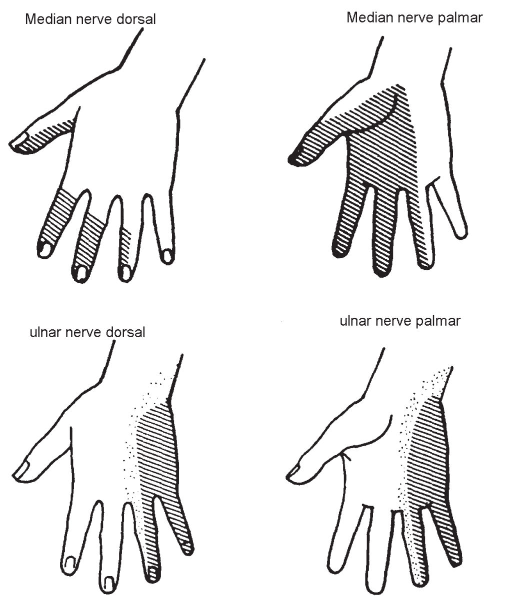


Figure 1
Sensory areas of the median and the ulnar nerve (1)

Methods

All subjects had 15 minutes acclimatisation to a room temperature of 24° C with bare arms. Thermal images were performed of the dorsal hands prior to a cold stress test (CST, 3) and immediately, 5, 10 minutes after. 15 minutes after the CST images were taken from 42 hands and at 20 minutes after CST thermograms were available from 30 hands. The imaging was performed with either an Agema 870 or NEC san-ei thermotracer.

Regions of interest were defined on each thermogram: the index finger for the median nerve and the little finger for the ulnar nerve. Additionally the areas of the sensory distribution on the dorsum of the hand for each nerve were defined following the template shown in figure 1. In all patients nerve conduction measurements of both median nerves were performed.

Descriptive statistics were applied to the results. Temperature differences between the index and little finger (df =temperature of the index (it) minus temperature of the little finger, (lt)) and the difference of the temperature of the median and ulnar innervated areas (d=temperature of the sensory area of the median nerve (mt) minus temperature of the ulnar nerve area (ut)) were calculated. Absolute temperature values and temperature differences were correlated at each measurement interval. Finally the difference of d minus df was calculated.

Results

52 hands of 26 subjects (10 men and 16 women, age (mean ± standard deviation): 58.4 ± 18.4) were investigated. Table 1 shows the correlation coefficients between the tempeature of index and median nerve area and little finger and ulnar nerve area at each measurement interval.

Prior to the cold stress test the mean temperature of the index was 0,.06 degrees higher than the mean temperature of the median nerve area. At this measurement the little finger presented with a mean temperature of 31.93°C compared to 32.00 for the ulnar nerve area. Correlation coefficients of 0.98 and 0.97 were obtained indicating that these values were almost identical.

The lowest correlations calculated were 5 minutes after the cold stress test (0.85 and 0.88 resperctively). All other corelations were high, range = 0.94 to 0.99.

Mean values of the cumulated readings of all 4 regions of interest (index, little finger, median nerve area, ulnar nerve area) are given in figure 2.

Table 1 Correlations for the median nerve area

index finger		before	5 minutes post CST	10 minutes post KST	15 minutes post CST	20 minutes post CST
before	correlation coefficient	0.98				
	p-value	0,000				
	number	52				
5 minutes post CST	correlation coefficient		0.88			
	p-value		0,000			
	number		52			
10 minutes post CST	correlation coefficient			0,98		
	p-value			0,000		
	number			42		
15 minutes post CST	correlation coefficient				0.99	
	p-value				0,000	
	number				34	
20 minutes post CST	correlation coefficient					0.99
	p-value					0,000
	number					26

Table 2 Correlations for the ulnar nerve area

little finger		ulnar nerve area: before	5 minutes post CST	10 minutes post CST	15 minutes post CST	20 minutes post CST
before	correlation coefficient	0,97				
	p-value	0.000				
	number	52				
5 minutes post CST	correlation coefficient		0,85			
	p-value		0.000			
	number		52			
10 minutes post CST	correlation coefficient			0.94		
	p-value			0.000		
	number			52		
15 minutes post CST	correlation coefficient				0.97	
	p-value				0.000	
	number				42	
20 minutes post CST	correlation coefficient					0.96
	p-value					0.000
	number					30

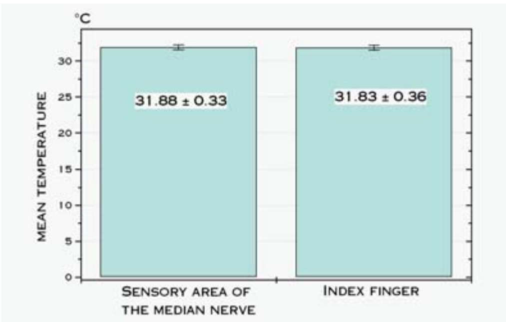
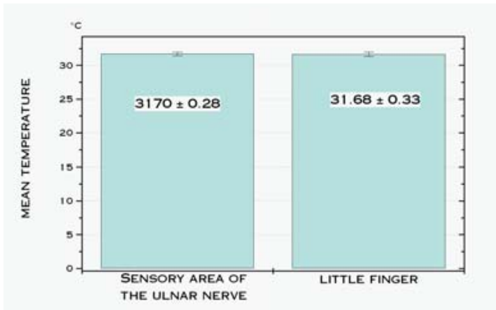


Figure 2 a
Mean temperatures (± 95% confidence interval) of the sensory area of the median nerve and the in-



Figuree 2 b
Mean Temperature (± 95% confidence interval)

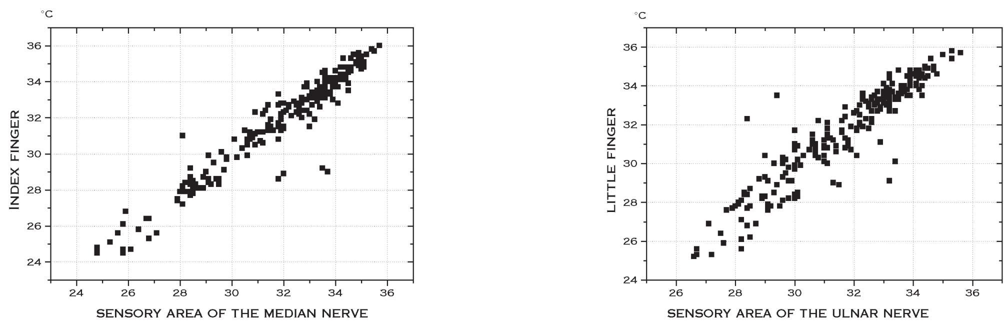


Figure 3

Figure 3 show scatter plots of the cumulated temperature values of the index and the median nerve area, and of the little finger and the ulnar nerve area respectively.

For the cumulated file the difference of d minus df was within a 95% confidence interval of -0,03 und 0,29 degrees.

16 hands presented with a distal latency longer than 6.0msec and in 16 hands the distal latency was in the range between 4.4 and 6msec. The remaining 20 hands showed normal values for the distal latency. The correlation between the temperature of a single finger and the sensory nerve area was not different in hands with delayed or normal distal latency.

Discussion

The first studies on thermal imaging of patients with carpal tunnel syndrome used thermograms of the palm of the hand (5,6,7), where the sensory area is easy to define. Tchou was the first (8,9),to performe thermal images of the dorsum of the hands in entrapment syndromes of the median nerve, although his positioning of the regions of interest differed slightly different from ours. For some investigators the dorsal view has been the standard position for thermographic studies in patients with carpal tunnel syndrome (1, 4, 10).

Although comparisons of interside differences of designated regions of the hand and fingers were used for the thermographic assessment of carpal tunnel syndrome (3, 11), the correlation between the temperature values of a single finger and the temperature of the total sensory area of a peripheral nerve has not been previously investigated.

Another problem for the correct positioning of measurement area arises from the fact, that the distribution of the sensory fibers may vary between individual subjects. A recent study using sensory nerve action potentials questioned the sensory innervation of the middle finger by the median nerve, which may sometimes be supplied with sensory fibers by the ulnar nerve (12).

The frequent anastomoses between median and ulnar nerve (Martin Gruber,13). can be detected by nerve conduction studies. However, this investigation must be performed prior to thermal imaging to have an impact on the placement of regions of interest.

Even when the innervation field of sensory fibers can be defined with certainty, the distribution of sympathetic nerve fibers in the same area as the sensory fibers should be proven. The abundance of autonomic nerve fibers in the median nerve was described (1). Lang et al. used thermography to assess the function of autonomic nerve fibers in healthy subjects and in patients suffering from carpal tunnel syndrome (14): They could not show that the autonomic response elicited either by Vasalva maneuver or painful stimuli was restricted to the innervation areas of the median or ulnar nerve. The same reactions were observed in healthy subjects and in patients with carpal tunnel syndrome. The authors concluded that the sympathetic nervous system may not be affected in carpal tunnel syndrome.

The lowest correlation rate of the temperature readings of single fingers and sensory nerve areas was found 5.minutes after the cold stress test. This may be caused by the fact, that in the early phase of rewarming edge detection of the hand can be very difficult due to the low temperature contrast between the hand and the background. This can lead to mis-definition of the region of interest and to incorrect temperature readings.

Conclusion

Our results provide evidence, that the temperature of the index or the little finger correlate highly with the temperature of the sensory area of the median or ulnar nerve respectively. Therefore, temperature readings of the second and the fifth finger can be used to represent the areas on the dorsum of the hands innervated by the median or the ulnar nerve.

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Thermographic Evaluation of the Head and Face Under Differentiated Altitude Hypoxia

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Summary

The aim of the study was to estimate the skin surface of the head (under resting conditions) which results from 40 min of differentiated altitude hypoxia exposure. The experiments were carried out in the thermo-barochamber under controlled environmental conditions. Every subject was examined in the same manner at a simulated altitude of 2.500, 3.500 and 4.500 m over sea level (control at 115 m o.s.l.).

It was found that proportionally to the time of exposure to altitude hypoxia 2.500 and 3.500 m o.s.l. the mean value of head skin temperature recorded by an IR camera (AGEMA Thermovision 900 Systems AB, Sweden) did not reveal any significant abnormalities. The isotherm distribution on the facial surface was similar to the image recorded under control conditions. In response to a stimulus of hypoxia, corresponding to the altitude of 4500 m o.s.l., the facial surface was distinguished from the rest of body surface by different dynamics and the course of temperature changes. The recorded thermograms were warmer. A differentiated increase in heat emission from head surface occurred before the decrease in brain temperature, which, during the last minutes of exposure to hypoxia corresponding to the altitude of 4.500 m o.s.l., was on the average 0.3 °C lower compared to the initial value.

Key-words: altitude hypoxia, thermography, head surface, thermal pattern.

Thermographische Beurteilung des Kopfes und des Gesichtes unter Hypoxie in unterschiedlicher Höhe

Die Studie berichtet über die Änderungen der thermischen Reaktivität im Bereich der Kopfhaut (im Ruhestand), die durch ein 40 Minuten dauernde Exposition auf unterschiedlichen Seehöhen und den damit verbundenen Sauerstoffmangel hervorgerufen wurde. Die Untersuchungen wurden in einer Thermo- Barokammer unter standardisierten physikalischen Umgebungsbedingungen durchgeführt. Jeder Proband hat vier mal an einem gleichartigen Modelluntersuchung teilgenommen, die auf einer simulierten Höhe von 2500, 3500 und 4500 m über dem Meeresspiegel durchgeführt wurde (die Kontrolluntersuchung 115 m. über dem Meeresspiegel) . Während der Exposition auf eine Höhe von 2500 und 3500 m über dem Meeresspiegel wurde keine wesentliche Änderungen der durchschnittlichen der Temperaturwerte auf der Gesichtsoberfläche festgestellt, was mit Hilfe von IR Kamera (AGEMA Thermosision Systems AB, Schweden) registriert wurde. Die Verteilung der Isothermen im Gesicht war dem Bild unter Kontrollbedingungen annähernd gleich. Der Sauerstoffmangel in einer Seehöhe von 4500 m bedingt an der Oberfläche des Gesichtes eine andere Temperaturdynamik im Vergleich zum Rest des Körpers . Auch der Verlauf der Temperaturverteilung war unterschiedlich. Die registrierten Thermograme zeigten höhere Temperaturwerte. Der differenzierte Steigerung der Wärmeemission von der Oberfläche der Kopfhaut war eine Verminderung der Gehirntemperatur vorausgegangen, die in den letzten Minuten der Exposition auf einen Sauerstoffmangel, einer Seehöhe von 4500 m entsprechend, durchschnittlich um 0,3°C niedriger war als der Ausgangswert.

Schlüsselwörter: Sauerstoffmangel in grosser Seehöhe, Wärme-Elimination, Thermographie

Introduction

The human body at high altitudes is exposed to the effect of hypoxia. The term „hypoxia“ is used to define changes in human body function, evoked by the decrease in oxygen saturation in the inhaled air. Special compensatory mechanisms are involved to maintain homeostasis under such conditions. The course of adaptive processes occurring in the human body takes three independent directions, namely increase in oxygen intake and the effectiveness of tissue oxygen utilisation, and the reduction of oxygen requirement. The decrease in human body temperature described as a „hypothermic effect of exposure to altitudes “ (7,8) may constitute one of the basic mechanisms, compensating oxygen deficiency in human organism (5). Evaluation of the range of these responses is still one of the basic research trends in aviation medicine. High altitude hypoxia is one of the major threats to a pilot's ability to perform complex tasks.

Body temperature reduction has a direct effect on tissue metabolic requirements and the activity of most metabolic processes. Adaptive changes in different organs, occurring under acute hypoxic conditions are differentiated, depending on the organ that is involved. Brain is the most sensitive to hypoxic effects of all human organs (6). It may be beneficial that selective brain cooling (SBC), described under hyperthermic conditions in humans (1,3) can act as the mechanism protecting from the adverse effect of hypoxia. The literature suggests that in the case of human subjects, SBC contains structural systems and that such areas of head skin as facial and cranium surface form extracranial heat exchanger which is used for heat dissipation (1,3, 11). These problems have not been discussed so far for hypoxic conditions. This paper verifies that hypothesis.

Material and method

The observation was performed in the group of 6 male subjects (aged 24-30 years), who had given written consensus to participate in this study (as paid volunteers). The screening procedure for subjects was performed at the licensing division of the Institute. Each of the subjects was exposed to the same stimulus regarding the time and rate of altitude change, reaching the hypoxia levels: 2.500, 3.500 and 4.500 m above the sea level (o.s.l.). In three subjects with shaved heads, the thermal image was recorded on the entire head surface. Each subject participated twice in the accepted test run. Three day intervals between consecutive test runs were adopted.

The experiments were carried out in the thermobarochamber under controlled environmental conditions (Ta = 26°C, RH = 45%, air flow rate below 0.2 m/s). The inhomogeneity of air temperature in the chamber did not exceed 0.1°C/m.

Each test run consisted of the 20 min of adaptation period (base line) and the 40 min of exposure to the pre-set level of altitude hypoxia. The control data were gathered in the same group of subjects, at the pressure corresponding to the altitude of 115 m o.s.l. At the same time physiological parameters (heart rate and breathing frequency) were being continuously recorded for the control group. In abnormal responses of the circulatory and respiratory system at rest, the study was not classified as positive.

The evaluation of body surface temperature distribution was performed with the aid of an IR camera (AGEMA Thermovision 900 Series, Sweden, scanner LW with 20° lenses without filters). The system consisted of compu- terized digital recording and analysis subsys- tems for real-time image visualisation. For soft- ware implementation Erica 3.11 with additional options was used**.** The measurement was performed inside the thermobarochamber and repeated at 5 min. intervals, using front and side head positions, from the distance of 0.8 m.

The areas, characterised by significant reactivity of temperature changes were analysed. Mean values of surface temperature were determined in the areas of: face skin surface (T_{sf}), skull cap (T_{sc}) and v. angularis oculi (T_{va}). Tympanic temperature was measured using a KTC-11 „THERA“ thermometer with the accuracy 0.01 ^{O}C. A temperature sensor was placed near the tympanic membrane in such a way, that lateral (thermally insulated) surfaces did not touch the walls of the auditory canal.

Results

During the control studies (normobaria, 115 m o.s.l.), the mean temperature of the facial surface (T_{sf}) was maintained at the level of 34.4

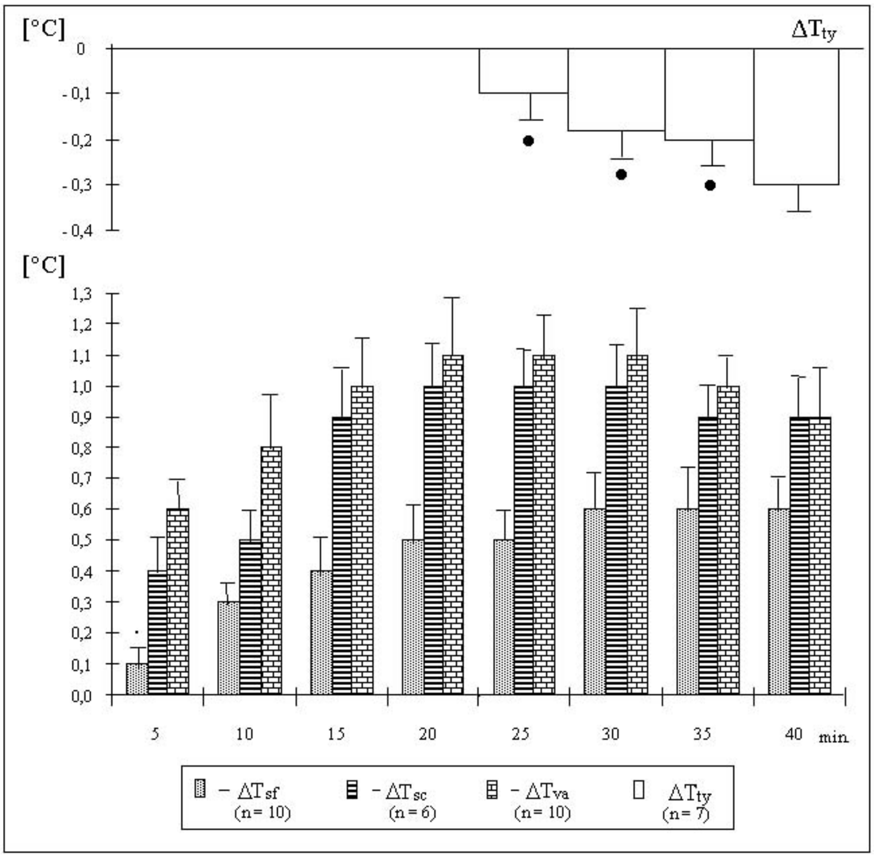

Figure 1
Temperature values during 40 min of exposure to high altitude 4500 m over the sea level (o.s.l.). T_{sf} – face surface, T_{sc} – cranium surface, T_{va} – area of v. angularis oculi and T_{ty} - tympanic temperature related to analogous values registered under control conditions (115m o.s.l.). •

±0,6°C. During the 40 min. observation period, slight, but statistically insignificant deviations occurred. Under the same ambient thermal conditions of hypoxia, corresponding to the altitude of 4.500 m o.s.l. the recorded thermograms were warmer (figure 2). The increase in facial surface temperature (T_{sf}) was particularly pronounced during the first minutes of examination (figure 1). The first thermograms recorded within 5 min. of hypoxia exposure, revealed apparent increase in temperature near the inner ocular angle. This area corresponded with the anatomic location of v. angularis oculi. (Figure 2).

The increase in temperature was not due to the uniform changes occurring on the whole face surface. During the exposure to hypoxia corresponding to the altitude of 4500 m o.s.l., selected areas were activated on head surface. These areas were characterised by greater dynamic changes of temperature . The dynamics of T_{va} and temperature of cranium surface (T_{sc}) significantly exceeded mean temperature value growth on the whole face surface (T_{sf}). The observed changes significantly increased during the initial period of exposure time (figure 1).

In the area of v. angularis oculi, the isotherms with increased values adjoined, with exposure time, the equally active lower face skin surface (figure 2). At the same time, the increase in temperature on the forehead and skull cap surface was recorded (figures 1, 2). These two areas joined with exposure time, and the thermograms recorded during the last minutes of the study revealed, that they spread almost the entire area of the cranium. Simultaneously, the

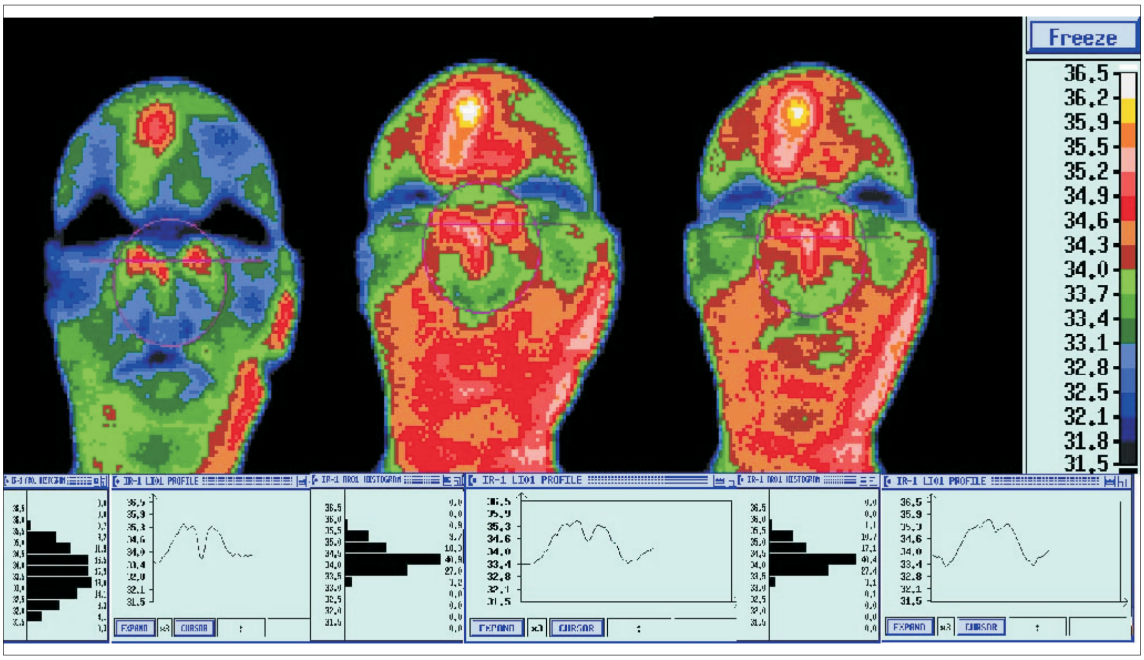

Figure 2
Pattern of head temperature (frontal) in altitude hypoxia (4.500 m o.s.l.) at the beginning of exposure - A, 20 min. - B and 40 min. - C
with the profile diagram and temperature histogram for the area including v. angularis oculi.

growth of the highest value of the isotherm field surface was observed (figure 2). It was noted that slight decrease in T_{va} and T_{sc} temperature, observed during 35-40 min. of exposure, occurred only in subjects with shaved head skin surface.

Despite the existing individual differences, manifested by different value and field dimensions distribution for each isotherm, the observed direction of changes was identical in all subjects. Each time, the same areas of face skin surface were activated, preserving the same time correlations.

The decrease in tympanic temperature occurred after 25 min. of the examination. The tendency to decrease was maintained till the moment of the exposure end. During the 40th min., T_{ty} was on the average 0.3±0.07 lower than the control value (figure 1).

At the same time, it was noted that the thermograms recorded in the same subjects after 40 min. of exposure to hypoxia corresponding to altitudes of 2.500 and 3.500 m o.s.l. did not show any of the described changes, characteristic for hypoxia level of 4.500 m o.s.l., both related to the mean temperature value of face surface and distribution of isotherms of the increased value in the area of v. angularis oculi, and skin surface of forehead and cheeks (figure 3). Temperature pattern of the face was similar to the image recorded under control conditions (115 m o.s.l.)

Discussion

The discussion concerning the question whether the human organism has to maintain the same energetic status under conditions of limited oxygen flow to body tissues, and whether the decrease in the general energetic level of human body may occur as a deliberate and not side effect of adaptive processes suggests that brain cooling strategy may be used as defensive mechanism against hypoxia.

The impairment of brain function evoked by hypoxia is directly connected with brain metabolism (6). Cerebral tissue is extremely hypoxia susceptible. From the point of view of anthropogenesis, we cannot exclude, that in the course of brain evolution, some processes developed, enabling to preserve its function under conditions of oxygen deficiency. The results of numerous studies provided enough evidence for its significant plasticity. Finally, the described

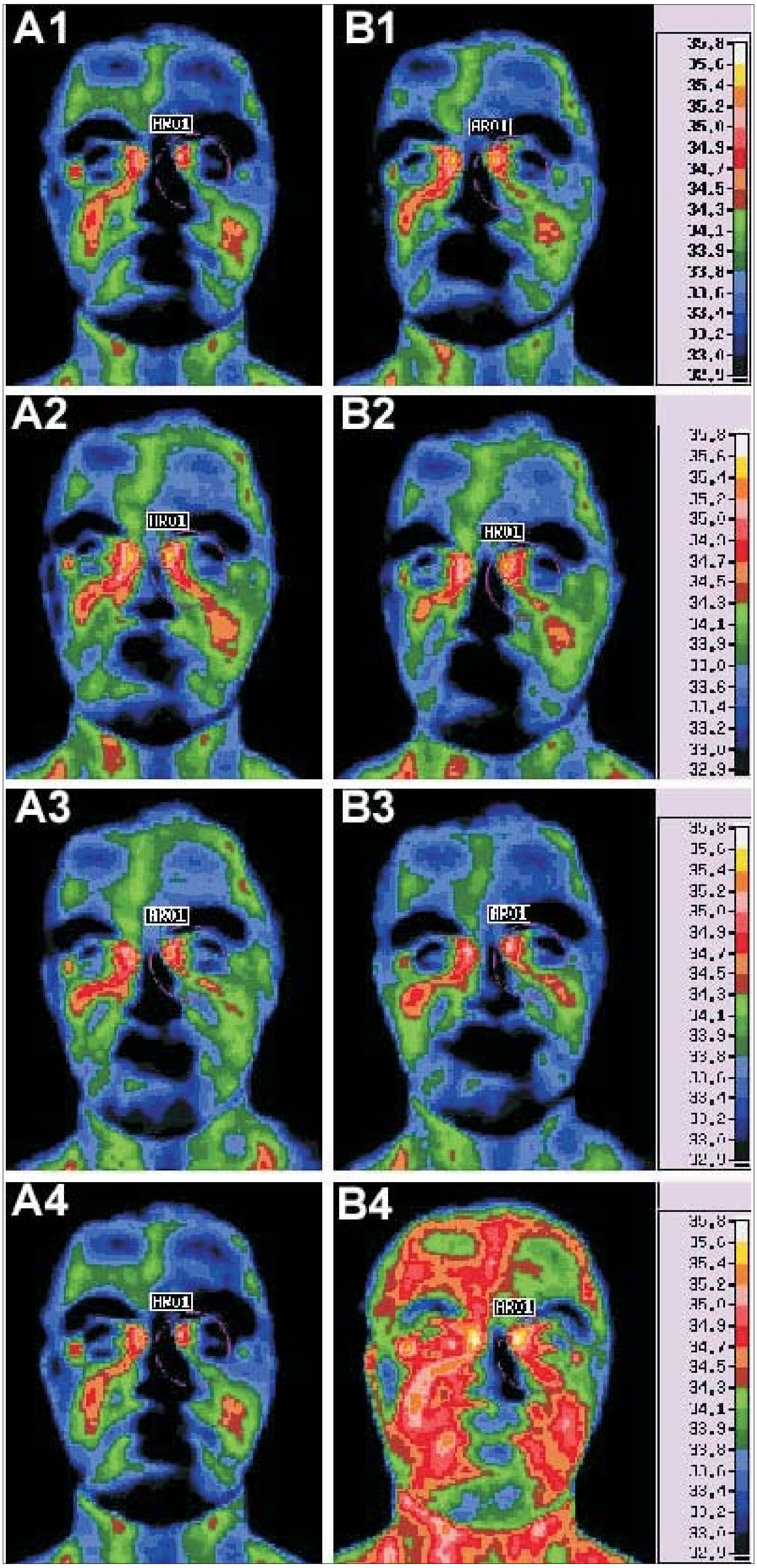

Figure 3
A1 – A4 pattern of head temperature registered before the exposure to normobaria, at the level of 115 m over the sea level (o.s.l.)

Right side thermograms registered in 40th min of examination at altitude: 115 m. o.s.l.(control) – B1, 2.500 m o.s.l. – B2, 3.500 m o.s.l. – B3 and 4.500 m o.s.l. – B4.

general role of SBC as the mechanism protecting cerebral tissue from thermal damage under hyperthermic conditions does not exclude the hypothesis that brain cooling has a protective effect under hypoxic conditions (3,5).

The recorded thermal images of the head surface revealed that 1) during the exposure to hypoxia corresponding with lower altitudes (2.500 and 3.500 m o.s.l.), temperature changes on the facial surface were relatively small with their course being in accordance with temperature decrease observed on the rest of body surface 2) during the exposure to hypoxia corresponding to the altitude of 4.500 m o.s.l., the recorded thermograms were warmer, and the observed changes of temperature value ran in the direction opposite to those occurring in the area of the trunk and limbs. The increase in mean facial temperature value did not occur as an effect of its regular growth. First of all, the area of v. angularis oculi was characterised by greater dynamics of temperature changes . Basing on the above mentioned findings, we can conclude that facial skin surface is distinguished by different dynamics and temperatures change course, in response to the stimulus of hypoxia corresponding to the altitude of 4.500 m o.s.l.

The described sequence of events suggests that hypoxia corresponding to the altitude of 4.500 m o.s.l. evokes the process of increased heat flow on the head skin surface.

The occurrence of hotter isotherms near the inner ocular angle and also on face and cranium surface, suggests the increase in heat emission by means of radiation and convection. The significant role of v. angularis oculi in the process of heat shift between the intracranium and extracranial heat exchanger on the head surface was shown for SBC under hyperthermic conditions (1,2,3). The observed course of the most important differences in local temperature gradients was surprisingly similar in all subjects. The image of those changes lead us to conclude that, similarly to the described SBC mechanism, revealed under conditions of hyperthermia, the facial skin surface acts as an external heat emitter. The occurrence of increased heat emission areas on the cranial surface (figure 2) suggests the possibility of excessive heat elimination through the emissary veins which, emerging from the skull cap, connect the venous sinuses of dura mater with the system of superficial veins. The possibility of such a method of heat transport from the inside to the head surface, under conditions of the SBC mechanism, is suggested by other authors (1,2). The role of those veins in the process of excessive heat elimination is confirmed in the anthropogenesis development of the humans (4).

The decrease in tympanic temperature always occurred after the increase in heat flow to the head surface (figure 1). The results do not exclude the recorded decrease of T_{ty} to be the consequence of these changes. Although the T_{ty} measurement still needs further discussion, the parallel changes in tympanic and mean brain temperature in humans is supported by the literature (9).

Characteristic isotherm distribution on the head surface did not occur during analogous studies performed under altitude hypoxia conditions of 2.500 and 3.500 m o.s.l. As there is no further evidence supporting this hypothesis, we can only presume that at „lower altitudes“, physiological regulation is sufficient to maintain brain homeostasis. It is possible that with such oxygen deficit, lowering of the metabolism level is not necessary, or the potential excess of metabolic heat is directly transmitted to the outflow of cooler arterial blood. The increase in cerebral blood flow accompanying hypoxia does not exclude this possibility (10). The decrease in brain temperature may protect highly aerobic tissues from the adverse effect of altitude hypoxia.

Acknowledgement

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12.Thermologisches Symposium am 8.Mai 1999

veranstaltet von der
Ludwig Boltzmann Forschungsstelle für Physikalische Diagnostik
und der Österreichischen Gesellschaft für Thermologie

Diese Veranstaltung wird wesentlich durch
die Magistratsabteilung 18, finanziell gefördert.

STADTPLANUNG WIEN

Magistrat der Stadt Wien, MA 18
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Außerdem danken wir den Firmen
Novartis, Wien
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Sanova Pharma, Wien
für die freundliche Unterstützung

PROGRAMM

Vorsitz. O.Rathkolb (Wien), J.R. Harding (Newport))

9.00 *F.Ring* (Bath)
Quantitative Infra Red Imaging and
Effects of Drug Therapy in Rheumatology

9.20 Diskussion

9.25 J.R.Harding, D.F.Wertheim, R.J.Williams, J.M.Melhuish,
D. Banerjee,K.G.Harding (Newport)
Thermographic Monitoring Of Antibiotic Therapy For Osteomyelitis In
Patients With Diabetic Foot Ulcers

9.45 Diskussion

9.50 K.Ammer, B.Engelbert, S.Hamerle-Reiter, E.Kern (Wien)
Thermographische Veränderungen nach physikalischer Therapie bei
Patienten mit aktivierten Arthrosen, Algodystrophie oder generalisierter
Fibromyalgie

10.05 Diskussion

10.10 A. Jung, J. Zuber, B. Wiecek, B. Kalicki, M. Stanczyk, M. Osiecki,
P. Twardowski (Warschau/Lodz)
Infrared Thermographic Imaging Of Critical Leg Ischaemia

10. 30 Discussion

10.35- 11.15	Kafeepause
	Vorsitz: K.Ammer (Wien), F.Ring (Bath)
11.15	G.Dalla Volta (Brescia) Telethermographic Monitoring Of Treatment In Patients With Migraine
11.35	Diskussion
11.40	T.Schartelmüller, K.Ammer, P.Melnizky B.Engelbert (Wien) Therapiemonitoring durch Infrarot- Thermographie nach Heilgymnastik
11.55	Diskussion
12.00	P. Melnizky, K.Ammer, T. Schartelmüller, B. Engelbert, O. Rathkolb, S. Hamerle-Reiter, W. Reiter, S. Sajer. E.Kern (Wien) Infrarot-Thermographie in der Diagnostik von Nervenengpasssyndromen
12.20	Diskussion
12.25	B. Wiêcek, Anna Jung, J.Zuber (Lodz, Warschau) Emissivity - bottleneck and challenge for thermography
12.45	Diskussion

Kurzfassungen

Quantitative Infra Red Imaging and Effects of Drug Therapy in Rheumatology

Francis Ring

Dept Clinicat Measurement, Royal National Hospital for Rheumatic Diseases, Bath UK

Early studies with infra red thermography in the 1970-1980's showed that arthritic inflammation produces localised heat which is especially easy to identify around the peripheral joints. Treatment using anti-inflammatory agents can therefore be monitored by thermography to assess efficacy shown by a reduction in that raised temperature (1). The most common joints which can be assessed in this way are the knees, hands, elbows and ankles. lndividual toes and fingers may be used, but can be more difficult unless there is acute inflammation present which is well localised such as in gout.

Local injection therapy with prednisolone derivatives has been successfully monitored in trails to compare different compounds. We have shown that the larger the molecule the longer the localised anti inflammatory effect and the lower the blood cortisol levels (2).

Oral non- steroid anti-inflammatories with aspirin and its derivatives show a much slower response to treatment. Most studies have used analgesic paracetamol as a washout treatment prior to starting the test drug in groups of patients with active disease. These patients usually show an increase in temperature of the affected joints even though their pain levels may be suppressed. Changing treatment to the test drug then can show over a period of weeks that temperature is reduced depending on the potency of the agent and the patients response to treatment. These studies were performed with double blind placebo trials in arthritic patients, and also showed that dose response could be determined between separate groups of patients (3).

Current studies with thermography are being conducted using the latest focal plane array camera from FLIR/Agema on two groups of patients, In the first group we are assessing the antiinflammatory effect of a new human TNF- binding protein given by single intra-articular injection. A series of thermograms of the knee are recorded before, 24 hours after and 28 days post treatment. In the second group, patients with active Paget's disease of bone are treated in an open study with Alendronate.

The thermal index which is calculated from each therrmogram with dedicated software BTHERM provides an objektive measure of treatment response in rheumatology patients. The examination protocol is strictly maintained to minimise variables over time, all these examinations are conducted in a room at 20°C after a 15 minute stabilisation period.

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Thermographic Monitoring Of Antibiotic Therapy For Osteomyelitis In Patients With Diabetic Foot Ulcers

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Diabetic foot ulcers present a difficult problem in clinical management because of increased risk of soft-tissue infection in diabetes plus impaired local blood supply due to diabetic vascular disease. Infection of diabetic foot ulcers has particular risk of involvement of the adiacent bone resulting in the serious complication of osteomyelitis. This needs early aggressive antibiotic therapy to avoid even more serious secondary long-term complications, but unfortunately clinical diagnosis and radiological examination may be unhelpful in early osteomyelitis, when antibiotic therapy is most effective. Furthermore the large number of patients plus the chronic nature of diabetic foot ulceration precludes routine investigation for early osteomyelitis by X-ray or isotope bone scanning in every case, for logistic, radiation protection, and cost reasons. A previous preliminary study has shown significantly increased temperature on infrared imaging, not only around the ulcer, but in the entire foot in patients subsequently confirmed radiologically as having early osteomyelitis. This follow-up study has confirined osteomyelitis, developing up to 2 months later, in some subjects vith abnormal thermograms but normal radiographs on initial presentation, and has shown a return to a normal thermographic appearance in other patients in whom radiological examination has shown resolution of ostemyelitis following intensive antibiotic therapy.

Thermographische Veränderungen nach physikalischer Therapie bei Patienten mit Kniegelenkserguss, Algodystrophie oder generalisierter Fibromyalgie

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Ziel einer Physikalischen Therapie ist es, die Symptome des Patienten zu mindern. Wenn solche Krankheitszeichen von thermischen Phänomenen begleitet sind, kann der Therapieerfolg mittels Thermographie dokumentiert werden.

Es wird über die Behandlung von drei kleinen Patientengruppen berichtet, die in unterschiedlicher Weise eine Rückbildung der temperaturabhängigen Symptome nach Physikalischer Therapie boten.

Bei der generalisierten Fibromyalgie können vermehrt hot spots in der Umgebung der typischen Druckschmerzpunkte gefunden werden. 12 Patienten (9 Frauen, 3 Männer, Alter. 51,8 ± 10,5 Jahre) wurden mittels Sprudelbad und Heilgymnastik behandelt. Während die Zahl der Druckschmerzpunkte sich veringerte (von durchschittlich 15,7 ± 2,5 auf 12,4 ± 4,29), blieb nach der Therapie die Zahl der hot spots praktisch unverändert (9,4 ± 2,1 vor Behandlung; 9,5 ± 2,2 nach Behandlung)

Bei 10 Patienten mit posttraumatischer Algodystrophie (6 mal Sprunggelenk, 4 mal Handgelenk) konnte nach der Kombination einer Hochvolttherapie mit Heilgymnastik eine deutliche Temperaturverminderung über der erkrankten Region beobachtet werden. Am Beginn der Behandlung war das betroffene Gelenk um 1,7 ± 0,2 Grad wärmer als die Gegenseite. Nach Behandlung betrug die Temperaturdifferenz nur mehr 0,9 ± 0,3 Grad. Wie bereits früher beschrieben (1), ging die Abkühlung auch mit einer Schmerzminderung und Verbesserung der Beweglichkeit einher.

Bei 10 Patienten wurden posttraumatische Kniegelenksergüsse physikalisch behandelt und die weitere Symptomentwicklung thermographisch überwacht. Es war nur eine geringe Abkühlung über dem Kniegelenk zu beobachten, die mittlere Seitendifferenz betrug vor Therapie 1,8 und nach Therapie noch immer 1,7 Grad. Das Knie eines Patienten mit einer Totalendoprothese blieb nicht nur deutlich geschwollen, sondern auch deutlich überwärmt (Temperaturdifferenz zur Gegenseite zwischen 1, 3 und 2,8 Grad). Schließlich musste dieser Patient einer Reoperation zugeführt werden.

Zusammenfassend kann gesagt werden, dass sich der Effekt einer physikalischen Therapie bei der Algodystrophie mittels Infarot-Thermographie gut dokumentieren lässt. Bei posttraumatischen und postoperativen Hyperthermien am Kniegelenk ist innerhalb von 4 bis 6 Wochen nur mit einer geringen Rückbildung zu rechnen, wie auch Mayr (2) gefunden hat.

Bei der generalisierten Fibromyalgie, bei der ein Zusammenhang zwischen Tender Points und Hot Spots noch nicht geklärt ist, ist die Verminderung der Zahl von schmerzhaften Druckpunkten offensichtlich nicht von einen Verschwinden der Hot Spots begleitet. Damit scheint das Zählen von Hot spots keine ausreichend responsive Methode zur Therapiebeurteilung bei Fibromyalgie-Patienten darzustellen.

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Infrared thermographic imaging of critical leg ischaemia

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Technical University of Lodz, lnstitute of Electronics, Poland [4]

Critical limb ischaemia (CLI) is defined by the following two criteria: persistently recurring rest pain requiring regular analgesia for more than two weeks and/ or ulceration or gangrene of the foot or toes, plus a systolic pressure blood pressure at the ankle < 50 mm Hg.

The purpose this study was the assessement of temperature changes before and after vascular reparative surgery. A ThermaCAM SC 1000 Inframetrics camera was used for temperature measurements.

Our report describes a case of a 60-vear-old female patient with 10 year history of arteriosclerosis obliterans with a ischaemic lower limb on the right side, lumbar symphatectomy and succesfull functioning of the right femuropopliteal prosthesis. She was admited to the surgical department' with symptoms and signs such as pain at rest, muscle stiffness and intermittent claudication (the pain free walking distance was 50 m). On physical. examinationi trophic changes of the skin of the right lower limb were observed.

Doppler ultrasound and angiography confirmed occlusion of the femuropopliteal prosthesis on the right side.

The indication für surgical intervention was limb salvage. During the operation an occluded femuropopliteal prosthesis was found. The surgical procedure included restoring of the prosthesis patency by embolectomy and profundoplasty with venous patch above the proximal part of the deep femoral artery.

Table 1

	Lower extremity right side		
	Hallux region	Posteror crural region	Posterior thigh
Before operation	30.75	30.24	30.90
After operation	28.60	29.80	31.40
After PgE_1 administration	25.48	29.39	31.20
	Lower extremity left side		
	Hallux region	Posteror crural region	Posterior thigh
Before operation	32.50	30.88	31.00
After operation	32.20	30.80	31.15
After PgE_1 administration	31.89	30.62	31.05

Table 1 shows the changes in temperature of the lower limbs, recorded before and after surgery and after 7 days of Prostavasine administration.

Because there was no evident clinical improvement of the perfuision of the lower limb, the surgical procedure was followed by 7 days of Prostavasin (PHE_1) administration.

Due to aggravation of the ischaemia of lower limb on the right side, our pationt required below knee amputation.

The infrared thermographic findings showed a strong correlation with the clinical picture. Our case report serves as a pilot study to illustrate the possible application of infrared thermography for objective quantification of the effects of reparative vascular surgery or drug treatment. Additional studies are needed to evaluate the use of infrared thermography as a diagnostic aid in the assessment of the clinical course of CLI.

Telethermographic Monitoring Of Treatment In Patients With Migraine

Giorgio Dalla Volta

Neurological Clinic of University of Brescia, Italy

The control of microcirculation in the facial area occurs through the coordinate action of two systems: the vasoconstrictive sympathetic system from the pericarotid plexus through the vidian nerve and sphenopalatin ganglion up to the first and second branches of trigeminal nerve and the vasodilator parasympathetic system from the superior salivatory nucleous through the greater superficial petrosal nerve which in turn contributes fibers to the vidian nerve.

In addition the so called trigemino-vascular system, composed of trigemial fibers directly connected to the vessels, may release vasoactive substances which are liable to affect the vasomotor tone,even though the effect is only vasodilatation.

Thermography is a valuable tool for the evaluation of quantitative changes of the extracranial vasomotion and the activity of the autonomic nervous system.

We would like to emphasize the ability of the thermography to discriminate between muscle contraction headache and the migraine type by detecting asymmetries in the vascularizaton of the forehead during the intercritical phase.

We have further suggested that it can be of value in the follow-up of patients by monitoring the clinical course of the disease or to evaluate the efficacy of the use of certain drugs to relief the pain, such as Sumatriptan, or of treatments such as acupuncture.

We have described the disappearance of the asymmetry in the forehead vascularization of migrain sufferers receiving succesful treatment in close relationship to the clinical course.

Therapiemonitoring durch Infrarot- Thermographie nach Heilgymnastik

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Hintergrund: Die Wertigkeit der Infrarotthermographie bei Patienten mit dem Verdacht auf ein Thoracic Outlet Syndrome (TOS) wurde bereits in mehreren Arbeiten nachgewiesen. Ziel dieser Studie war es nunmehr, die Tauglichkeit dieser Methode als Instrument zur Dokumentation des durch klinische Tests überprüften Therapiefortschrittes zu analysieren.

Methode: An einem Kollektiv von 18 Patientinnen im Alter von 34 bis 59 Jahren (Median 50) wurden die bekannten thermographischen Untersuchungen (Thermogramme der Handflächen vor und nach Hyperabduktionstest, Faustschlußprobe und Adson-Maneuver, Berechnung der Differenz der Temperaturen von Zeige- und Kleinfinger, normal >0,5°) vor und nach einer Serie von Einzelheilgymnastik durchgeführt und mit den Ergebnissen der klinischen TOS- Tests (Costoclavicular-, Hyperabduktions- und Adson- Test) verglichen. Der zeitliche Abstand zwischen erster und zweiter Thermographie betrug 3 bis 11 Wochen (Median 5).

Ergebnisse: Während es nach der Therapie subjektiv bei allen Patienten zu einer Besserung der Beschwerden gekommen ist, waren die Ergebnisse der klinischen Tests nur bei etwas weniger als der Hälfte besser als vor der Therapie. Dies bestätigt die bekannte Tatsache der hohen Zahl falsch positiver Ergebnisse der klinischen TOS- Tests. Die Ergebnisse der Infrarot - Thermographie korrelieren in diesem Sinne besser mit der Symptomatik der Patienten, denn der Mittelwert der Temperaturdifferenzen war sowohl vor als auch nach den Provokationstests bei der Kontrolluntersuchung geringer (vor den Tests: 0,66 → 0,40°, nach Hyperabduktion 0,70 → 0,50°, nach Faustschluß 0,57 → 0,41° und nach Adson 0,58 → 0,49°). Zum Teil waren diese Ergebnisse sogar signifikant, nämlich vor den Tests (p=0,001), nach Hyperabduktion (p=0,02) und nach Faustschlußprobe (p=0,01).

Diskussion: Die Infrarot- Thermographie bietet sich aufgrund der besseren Korrelation mit den subjektiven Ergebnissen als die klinischen Tests als diagnostisches Instrument zur Überprüfung des Therapiefortschrittes an. Somit ist diese Untersuchungsmethode nicht nur als primäres Diagnostikum des TOS zu sehen, sondern scheint sich auch als valides Mittel zum Therapiemonitoring zu eignen.

Infrarot-Thermographie in der Diagnostik von Nervenengpasssyndromen

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° GZ Physiko der Wiener Gebietskrankenkasse.

Ziel der Studie: Die Infrarot-Thermographie kann das Temperaturverteilungsmuster der Hände sichtbar machen. Wir wollten klären, ob die IR-Thermographie bei Patientin mit Akroparaesthesien der oberen Extremität in der Lage ist, eine Thoracic Outlet Syndrome (TOS)-Problematik von auf ein Carpaltunnelsyndrom (CTS) zurückzuführende Beschwerden zu differenzieren.

Methode: Insgesamt wurden 150 Hände klinisch, elektroneurographisch und thermographisch untersucht. Durch klinische Stresstests (Hyperabduktions-, Adson- und Costoclavicular-maneuver) provozierbare akrale Paraesthesien wurden einer funktionellen Raumenge der oberen Thoraxapertur zugeschrieben (Diagnose: TOS, n= 62). Für die Zuordnung zur CTS-Gruppe (n= 20) wurde eine elektroneurographisch nachweisbare Pathologie im distalen Streckenabschnitt des N.medianus gefordert. 34 Hände wiesen sowohl TOS-Beschwerden als auch einen positiven NLG-Befund auf. Schließlich konnten 34 Hände als gesund identifiziert werden.

Die IR-Thermographie wurde unter standardisierten Bedingungen durchgeführt, wobei vor und nach 3 speziellen Stresstests Thermogramme der Hände angefertigt wurden. Nach Einzeichnung von "regions of interest" über dem Zeige- und Kleinfinger wurden die errechneten Temperaturdifferenzen bei Werten unter 0,5 ° K als unauffällig, ab diesem Grenzwert als pathologisch befundet.

Ergebnisse: Beim Vergleich aller 4 Gruppen bezogen auf die Art der Temperaturunterschiede (gleich, wärmer, kälter) errechnete sich ein p von 0,004. Signifikante Unterschiede von Paardifferenzen (Mann Whitney U-Test) fanden wir zwischen TOS- Patienten und Gesunden für alle Messzeitpunkte. Hingegen sind CTS-Patienten von Gesunden thermographisch nicht aussagekräftig differenzierbar und erreichten ebensowenig wie alle anderen angestellten Vergleiche das Signifikanzniveau.

Bei Patienten mit Akroparaesthesien der oberen Extremität ist ein Temperaturgradient ≥ 0,5° K als thermographische Auffälligkeit zu werten, eine nähere diagnostische Zuordnung ist aber nur in Zusammenschau mit klinischen, elektrophysiologischen und anderen Untersuchungsergebnissen möglich.

Emissivity – bottleneck and challenge for thermography

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1Technical University of Lódz, Institute of Electronics, Poland, [2]Central Clinical Hospital MMU, Warsaw, Poland

In this paper we present the i mportant and difficult problem of emissivity evaluation for use in thermography. We underline the importance of different definitions of emissivity, especially directional and spectral. The measured emissivities for semitransparent dielectric materials are presented,in combination with the theoretical background to recalculate the emissivity for thin and multilayer components.

Additionally, a multichannel system is presented, which reconstructs 3D scene. The system gives the ability to transform 2D-pictures acquired from two or more cameras into 3D-graphics to use the 3D model of object's directional emissivity correction. This method requires at least two CCD cameras, because it's based on geometrical rules of stereoscopic sight.

THERMOLOGY
QUARTERLY NEWSLETTER

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1999 American Academy of Thermology Annual Meeting

Hyatt Regency Pier 66 Hotel, Ft. Lauderdale, Florida

The annual meeting, May 28-30, is under the leadership of Dr. Ed Teeple of Allegheny General Hospital. The program for the annual meeting is being finalized. Please contact Dr. Teeple for abstracts on works in progress.

To improve the content and variety of the board test, the American Academy of Thermology urges members to submit clinical cases, with the possibility of being included into the test. Please submit clinical cases by April 15. In order to expedite acceptance, fax or e-mail cases and bring hard copies to the meeting

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e-mail: AATUSA1@aol.com

Nomination for Secretary of the American Academy of Thermology

Philip Hoekstra, III, Ph.D.

Proposed: Srini Govindan, M.D.

Seconded: Alfred Pavot, M.D.

Philip Hoekstra, III, Ph.D., is the laboratory director of Therma-Scan, Inc., a Michigan based independent thermology reference laboratory. He received his doctorate from Wayne State University, in Detroit, for his work in cardiology and neurology at the Department of Physiology in the School of Medicine. Dr. Hoekstra is a second generation thermologist, with twenty-seven years of continuous and active clinical application of thermology in the fields of breast disease, cerebral-vascular insufficiencies,vascular cephalalgia, peripheral vascular insufficiencies, thyroid disease, musculo-skeletal disorders, and disorders of the peripheral nervous system. Dr. Hoekstra has continuously sought to improve the science of thermology by developing specific imaging technique, objective means of analysis, and comprehensive reporting. Currently, he is co-developing thirty-two bit analytic thermology software for Windows and actively promoting broad application of breast thermography.

Information about the American Academy of Thermology

The American Academy of Thermology was founded in 1968. The articles of incorporation and by-laws were established in 1983, in Vienna, Virginia. The national headquarters was at Georgetown University Medical Center, 3800 Reservoir Road, Washington, D.C., 2007.

The initial board of directors were:

1. Corinne Farrell, M.D.
2. Margaret R. Abernathy, M.D.
3. Charles E. Wexler, M.D.
4. Frank S. Billingsley, M.D.
5. Istvan Nyirjesy, M.D.

The objectives of the corporation are:

1. To establish and maintain standards of excellence in the practice of Thermology.
2. To establish and maintain standards of excellence in education and research in Thermology.
3. To promote and encourage contributions to medical and scientific literature pertaining to Thermology.
4. To establish personal contacts between those interested in Thermology, who may seek advice and assistance on technical, interpretative, and economic aspects of Thermology.
5. To encourage personal and scientific contacts between themologists and members of other medical and scientific specialities.
6. To establish periodic scientific meetings for the presentation of clinical and experimental observations on thermal biology.

The Academy has been active since its foundation in 1968, and the organization is 30 years old. Annual scientific meetings have been held with excellent presentations on basic and clinical research materials and clinical applications.

AMA Category I CME credits have been consistently provided for recent meetings.

The 1999 scheduled meeting is being held May 28-30 at the Hyatt Regency Pier 66 Hotel, Ft. Lauderdale, Florida. It is sponsored by the American Academy of Thermology and Allegheny General Hospital, Pittsburgh, PA. Course director is Ed Teeple, M.D.

Beginning 1999, Thermology international has been designated the official journal of the American Academy of Thermology. Annual meetings will consist of educational courses for understanding the technology and its health care applications, as well as, review courses for the American Board of Thermology. The members of the executive committee of the American Academy of Thermology encourage members to get trained and credentialed in order to apply this method to patient care. This technology is being used in the areas of pain management and in diagnosing and following patients with reflex sympathetic dystrophy. Also, the role of infrared imaging in areas dealing with headache, biofeedback, sleep disorders, occupational medicine, and forensic medicine has recently been presented in national/ international meetings and published. Because of it's ability to provide information that is not provided by other technologies, such as CT, MRI, PET scan, or neurophysiological studies (EMG and Current Perception Threshold) it can help health care by early diagnosis and treatment of conditions dealing with altered thermal regulation and saves health care dollars. Infrared imaging also has a role in disability evaluations.

Dr. Govindan, AAT President, invites interested physicians and clinicians to apply for membership, attend the annual meeting, get trained, and become certified before the window of opportunity is over in the year 2002. After that, the grandfathering period will expire, and a formal fellowship training will be required and applicants will need to take the American Board of Thermology Examination to get certified. For more information, contact the Office of the President.

Information about the American Board of Thermology

The American Board of Thermology was incorporated on May 3, 1988. The registered agent was Margaret Abernathy, M.D., and the location of the office being 1815 Beulah Road, Vienna, Virginia, 22180. The by-laws of the American Board of Thermology were also established dealing with membership, nomination and election, meeting procedures, approp riate committees and examinations, and other specific areas to fulfill the requirements in establishing the American Board of Thermology. Initially, the Fellows of the Academy were responsible for the development and administration of the Board Examination.

The Fellows were:

1. Margaret R. Abernathy, M.D.
2. Max Borten, M.D., J.D.
3. Jo Anne Haberman, M.D.
4. Harold J. Isard, M.D.
5. Ray N. Lawson, M.D.
6. Sumio Uematsu, M.D.
7. Travis Winsor, M.D.

Initial certification of the members was carried out, as well as future scheduled examinations. After the 1991 meeting, the American Board of Thermology was temporarily inactive. The American Board of Thermology was reactivated in 1996, with the establishment of the members of the board. The officers of the American Board of Thermology are:

1. Robert Jamison, D.O., President
2. Michael Anbar, Ph.D.
3. Andrew Fischer, M.D., Ph.D.
4. Gerald Goldberg, M.D.
5. Srini Govindan, M.D.
6. Daniel Ignacio, M.D.
7. Pierre LeRoy, M.D.

Following the 1998 annual meeting, the President and the Directors approved petition for wavier of examination and grandfathering for a limited period. The grandfathering allows people with expertise in Thermology, and who qualify, to participate and get creden- tialed by the American Board of Thermology.

The grandfathering criteria allows credit for AAT member's knowledge, publication, research, and for practical experience.

The American Board of Thermology is giving the active members of the Academy of Thermology an opportunity to be credentialed in the use of Thermography in their field.

The wavier for the examination, for the members, will be decided upon by their qualifications, training, and demonstration of expertise in Thermology. Opportunity will be provided for members to gain knowledge, in order to fulfill the requirements before the time expires for the wavier of examination.

Credit for the Annual Meeting

Only for AAT meetings of 1996, 1997, 1998, and future meetings.

Decision on Each Candidate

Following the review of the application by the ABT, the decision will be made on an individual basis.

Director of Thermography Laboratory

The position of Director is defined as follows:

Can be Hospital or Office based. Protocol should be consistent with AAT guidelines.

Tests should be done under the direct supervision of the Director. Director should interpret the tests, demonstrate personal knowledge of the protocol, and provide proof of Quality Assurance.

Office-based laboratories should be recognized by Local Health Care Organizations (HMO, Local Medical Society, Workers' Compensation, or similar organizations).

Active members or qualified persons contact:

Srini Govindan, M.D. ,

Office of the President

40 Medical Park, Suite 304

Wheeling, WV 26003

Phone: (304) 242-2503 Fax: (304) 242-2682

Email : AATUSA1@aol.com

ABT

American Board of Thermology

Petition for Waiver of Examination for Members

(For American Academy of Thermology Members with good standing)

Total number of **points** needed based on Education , Training, Certification, Experience, Research, Paper presentation, Publication, Knowledge, Skill, and CME credits of the American Academy of Thermology meeting or course attended = **350.**

	Maximum Points	**Score** Lab Director 5 Years or more	**Score** AAT Member Not a Lab Director
▹ **Education:** M.D., D.O., Ph.D., D.D.S.,or D.V.M.,	50	50	50
▹ **Training:** Post-graduate/ Residency, or other equivalent fellowship	25	25	25
▹ **Board Certification:** In your speciality, and in which you will use Thermography	25	25	25
▹ **Experience:** Director of Thermography Laboratory 5 years or more	50	50	—
▹ **Research and Publication:** For each Presentation or Publication, 10 points Maximum allowed: 10x10	100	—	—
▹ **AAT Annual Meeting:** For each meeting 50 points. 2x50=100	100	100	100
▹ **For each AAT/ABT Board Review Course** 50 points 2x50=100	100	100	100
▹ **Review or Present 20 cases with ABT exam board** (can bring your own cases \ or borrow/rent from AAT Library)	50	recommended	50
>**Total Score:**	**500**	**350**	**350**

Please feel free to copy this form as needed

ABT

American Board of Thermology

Petition for Wavier of Examination for Members

- Check the specific speciality for which you are applying for Certification in Thermology :
- Separate application is required for each speciality.

☐ Clinical Medicine/Surgery	☐ Disability Medicine
☐ Vascular	☐ Forensic Medicine
☐ Radiology	☐ Health Care Management
☐ Oncology	☐ Biomedical Engineering / Environmental/ Technical
☐ Pain Management	☐ Independent Medical Examiner
☐ Occupational Medicine	☐ Veterinary Medicine
☐ Neurology/Neurosurgery/Neuroscience	☐ Anesthesiology
☐ Cardiology	☐ Dentistry
☐ Orthopedics	☐ Ob/Gyn
☐ Emergency Medicine/Trauma	☐ Pediatrics

- All candidates applying for a speciality certification should have completed residency/ fellowship (or) have done research (or) published in their field.
- Mail copy of curriculum vitae and examination fee to AAT (Make checks payable to AAT)

Examination Fee = $ 450

Credit for 98-99 Dues Paid = $ 250

Balance Due = $ 200

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Application for Fellowship

Name:_______________________________________ Date:__________________

Lastt M First

Degree/Diploma: M.D. · D.O. · Ph.D.·

Area of Interest:

Clinical Medicine/Surgery · Vascular · Radiology · Veterinary Medicine ·

Forensic Medicine · Pain Management · Occupational Medicine · Disability Medicine ·

Anesthesiology · Neurology/Neurosurgery/Neuroscience · Cardiology · Orthopedics ·

Independent Medical Examiner · Health Care Management · Oncology · Dentistry ·

Ob/Gyn · Pediatrics ·· Biomedical Engineering / Environmental/ Technical ·

- Fellowships are offered for 1 week to 3 months. **Specify**:___________
- The emphasis will be on methodology, laboratory set-up, quality assurance, and interpretation.
- Active members of the American Academy of Thermology will pay a fee for the fellowship, based on their requirement, to the Academy. Transportation, boarding, and lodging are applicants responsibility.
- Once the application form is received and processed, the applicant will be notified of the acceptance for fellowship.
- A non-refundable fee of $50 is required when this form is returned. This will be credited towards fellowship dues.

Contact:

Choice of mailing address: ____

____

____

Telephone: (   ) _________-______________ **e-mail:** ________________________

Fax: (   )_________-________________

Preference for contact: Mail Fax E-mail

Please feel free to copy this form as needed.

To: Members of the American Academy of Thermology
From: Srini Govindan, M.D., President
Please circle answers and reply by fax

AAT Member____

1. What do you want to know about the Academy?
2. Do you want to serve in the committees ?
3. Do you have suggestions?
4. Do you have recommendations?
5. Do you want to present a case at the annual meeting?
6. Do you want to setup a thermography lab in your area?
7. How can the AAT interact with the membership better?
8. Do you plan to attend the annual meeting in May '99?
9. How do you want the Academy to contact you?
   Mail ・, Fax ・, Email ・ ?
10. What can the Academy do for you?
11. Can you contribute to the newsletter?
12. Would you like to publish in our journal Thermology international?
13. Do you support the Academy sponsoring a fellowship program?
14. Did you know certification in Thermology is now speciality oriented?
15. Do you want to receive the news letter by email?

Thermography Characteristics and Perspectives

1. It is non invasive.
2. It has clinical indications.
3. You can get trained
4. You can get certified.
5. It can improve your diagnostic skills.
6. It is helpful in Workman Compensation cases.
7. It has a role in disability ratings.
8. Useful in clinical research.
9. Images thermoregulation.
10. It is reimbursable.
11. Forensic criteria has been established.
12. Fellowships available.

American Academy of Thermology
<u>Nomination to membership</u>

Member making nomination________________________________**Date** ___________

I am nominating the following:

Nominees Name & Title ____

Board Eligible / Certified ____

Mailing Address____

____

Phone: ( )_____________ **Fax:** ( )___________________ **Email:** _________________

Please feel free to copy this form as needed

Mail to: Office of the President
40 Medical Park, Suite 304
Wheeling, WV 26003

(OR)

Fax to: Office of the President
(304) 242-2682

News in Thermology

11th International Conference on Thermal Engineering and Thermogrammetry (THERMO)

from the 16th to 18th of June, 1999 in the OSSKI Center (Törley Palace), Budapest XXII (Budafok) Anna u.5.

Objectives

The developments of measurement theory and technologies help the energy- conscious design of thermal engineering equipment and processes as well as the better understanding of thermal phenomena in living organisms.

The Conference will cover topics both the field of theory and application including new measurement concepts; transducer technique; thermal mapping; contact, optical and IRimaging; biomedical and biotechnological applications; thermal informatics, automatie methods and systems for industrial energy management and process control; heat loss detection and analysis; heat and mass transfer, utilization ofalternative 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 field of energy conservation, control of energy release and loss, protection of human environment, medical and veterinary applications, remote control through infrared sensors.

Organisation of the Conference

The language of the conferenee and abstracts is English. Oral presentations of papers and a poster session will be organized. Duration of each presentation will be limited 10 15 mi nutes and additional time for discussion will also be provided.

Venue

The conference is hosted by the OSSKI Center (Törley Palace, Budapest, XXII. (Budafok), Anna u. 5.) loeated in the vicinity of the famous Budafok wine cellars.

Information

Applieation Forms should be sent to:

Dr.Imre BENKÖ,

MATESecretariat, House ofTechnology, III. 318., H-1372 Budapest, POB. 451., Hungary.

Fax: +361-153-1406 Phone: +361-332-9571.

E-mail: mate@mtesz.hu

For any further information please contact the following address:

Dr.Irme BENKÖ, Technieal University of Budapest (BME), Department of Energy (DoE) H-1111 Budapest, Müegyetem rkp. 7. D.208., Hungary,

office phone. + 361-463-2568.
BME Fax: + 361-463-1110,
BME telex: 225931 muegy h.
DoE Phonelfax: + 361-463-3273 or -463-3272.
E-mail: energy@eta.enrg.bme.hu

Meeting of the PoIish Thermology Society in Zakopane in September 1999

The second conference of the Polish Society of Thermology will be held in Koscielisko ka Zakopanego on September, 18.-19. The congress president Prof.Dr.A.Jung invites everyone active in thermology to participate in this meeting. For further information contact the conference.secretariat at

Pediatric and Nephrology Clinic; Central CIinical Hospital, Military University, Sehool of Medicine

Szaserow 128 str 00-908 Warsaw-60, PL Tel. + Fax: +48226817236

Typical Thermal Images: a new Atlas

Prof.Anna Jung and coworkers are currently preparing a new book on thermography in English. The publication is intented as an atlas, which shows thermal images of typical indications forthermography in comparison with other imaging and diagnostic modalities. A series of images demonstrating typical changes of temperature over time in certain diseases will also be included. Experts from Poland and around Europe will contribute to trus publication.

Homepage of the German Society of Thermology (GST)

The homepage of the German Society of Thermology is now on the word wide web. Trus German site can be accessed by the address:

“hnp://www.thermology.org ”

and contains information on the tasks and intentions of the Society, two publications of the President of the GST including a small atlas with typical thermal images from rheumatology. This book published in 1984 also provides normal temperature values of knee, ankle, elbow, hand and finger joints.

Information on the G.Bergmann Award, the paper of the 1998 award and the participants in the award competition are provided. Links to manufacturers and distributers of equipment for thermal images are available.

A thermology forum is etablished but not yet in use, which will include the list of proposed meeting daters. Nevertheless, this site has useful information and is a sign, that the science of thermal imaging is active in Germany.

8th European Congress of Thermology

The EAT will organize the next, 8th European Congress of Thermology in the year 2000. The Italian Society of Thermology and also the German Society of Thermology have registered their interest to bring this congress into their country. The Committee of the EA T will decide on the definite venue of this conference at their next business meeting in Vienna on May8

Veranstaltungen (MEETINGS)

28-30. May 1999, Ft.Lauderdale

28th Annual Meeting and Board Review of the American Academy of Thermology

Venue: Hyatt Regency Pier 66, Ft.Lauderdale, Florida

Information: Srini Govindan M.D.

President, American Academy of Thermology

40 Medical Park, Suite 304

Wheeling; WV 26003

Tel +304 242 2503, fax: +304 242 2682

16-18 June 1999, Budapest

11th International Conference on Thermal Engineering and Thermogrammetry (Thermo)

Venue: OSSKI Center (Törley Palace) Budapest, XXII; (Budafok), Anna u.5

Conference language: English

Topics: General thermal engineering; theory of measurements; thermal informatics, thermo-CAD and its applications; industrial energy management and process control systems; practice of thermal engineering; infrar-red imaging science & technology, thermogrammetry; microscale thermal phenomena and sensing techniques, thermal defectometry; applied thermo-optics; thermo-physical properties; heat and mass transfer; cooling of electronic components; heat ex-changers; 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 bioengineering applications; multidisciplinary topics

Scientific Committee:

Chairman: Dr. I.Benkö, Hungary
Secretary: I.Kovacsics, MSc, Hungary
Members: Dr.K.Ammer, Austria
Dr.F.Arinc, Turkey
Dr.T.Ayhan, Turkey
Dr.W.Bauer, Germany
Dr.I.Dincer, Saudi Arabia
Dr.S.Kakac, USA
Dr.L.I.Kiss, Canada
Dr.G.J.Köteles, Hungary
Dr.A.Lallemand, France
Dr.S.Mochzuki, Japan
Dr.L.Radonyi, Hungary
Dr.S.Svaic, Croatia
Dr.L.de Thibault de Boesinghe, Belgium
Dr.W.-J.Yang, USA
Dr.B.Wiecek, Poland

Information: Dr.Imre Benkö
Technical University of Budapest (BME),
Department of Energy (DoE)
H-1111 Budapest, Müegyetem rkp 7.,
D.208 Hungary
office phone: + 361 463 2568
BME: Fax: +361 463 1110 BME telex: 225931 muegy h,
DoE Phone/fax; + 361-463 3273 or 463-3272
E-mail: energy@eta.enrg.bme.hu

24 - 26 June 1999 , Nagaoka(Japan)

AFPC´ 99 - Asian Pacific Conference of Thermology

2nd Conference of the Asian Pacific Federation of Thermology and 31 st Annual Meeting of the Japanese Society of Thermology

Main theme: Emerging New Era of Advanced lnfrared lmaging

Venue: Multimedia Center of Nagaoka University of Technology

Jointly *sponsored by:*

International College of Thermology

Asian Pacific Federation of Thermology

Japanese Society of Thermology

Korean Academy of Medical Thermology

Applied Medical Science Research Foundation

Multimedia Center of Nagaoka University of Technology

Information :

Professor lwao Fujimasa, M.D., Ph.D.
Chairman AFPC'99

National Graduate Institute for Policy Studies
19 Mori Building
1-2-20 Toranomon, Minato-ku
Tokyo 105-0001, Japan

Tel: + 81 3 3506 2529 Fax: + 81 3 3506 2531
e-mail goophy@grips.ac.jp

4.-6. July 1999, London

6th CONGRESS OF THE INTERNATIONAL SOCIETY FOR SKIN IMAGING (ISSI)

Venue: The Royal Society, London, United Kingdom

Topics: Imaging in the Diagnosis and Management of Skin Cancer, Imaging Methods in Skin Pharmaacology, Measurement in Cosmetic Dermatology, Skin Surface Imaging, ELM , Ultrasound, MRI , Optical Tomography and Holography, Spectroscopic Imaging, Fluorescence Imaging, Topometry, Profilometry, Interferometry, **Thermal Imaging**, Imaging the Microcirculation,Laser Doppler Imaging, Elasticity Imaging, Nuclear Imaging, Computer-assisted Image Analysis, Picture Archiving, Telemedicine, Computer Data- bases, Multimedia

Presidents:J.G. McVie (UK), RJ. Hay (UK)

Chairmen: J Bamber (UK), S. el Gammal (Germany), P. Mortimer (UK), F. Ring (UK)

Local Organizing Committee (UK):
K. Humphries (Secretariat), D. Cosgrove, P. French, R. Imhof, S. Young

Local Advisory Board (UK)**:** C. Griffiths, C. Harland, R. Marks, R. Ott, J Rees

*International Scientific Board:*J. Bamber (UK), M. Burronio (Italy), A. di Nardo (Italy),S.el Gammal (Germany), K. Hoffmann (Germany), A. M. Kligman (USA),G.Nilsson (Sweden), H. Pehamberger (Austria), D. Perednia (USA), B. Querleux (France),F.Ring (UK), S. Seidenari (Italy),J. Serup (Denmark), W. Stolz (Germany), M.Stücker (Germany), H. Takiwaki Japan), L. Vaillant (France), A. Zemtsov (USA)

Organized with the support of. The Institute of Cancer Research, The Cancer Research Campaign

Under the patronage of - The International Society for Digital Imaging of the Skin (ISDIS), Tne International Society for Bioengineering and the Skin (ISBS)

Secretariat (for ALL enquiries):
HITEC (Hammersmith Hospital),
Du Cane Road, London W12 OHS, UK.
Tel: +44 181 383 1608 Fax: +44 181 383 1610
E-mail: hitec@rpms.ac.uk

18.-19.September, Zakopane

2nd Congress of the Polish Society of Thermology "Thermovision in Medical Diagnostics"

Deadline for abstracts:

Venue: DW "SYWARNE"

34-511 Koscielisko k.Zakopanego

Ul.Sywarne 32

Information:
Pediatric and Nephrology Clinic,
Central Clinical Hospital, Military University,
School of Medicine
Szaserow 128 str
00-909 Warsaw-60, PL

Tel/fax +48 22 6817236

29.-30.September, 1999, Venezia

5th International Workshop on Advanced Infrared Technology and Applications

Venue: CNR-ISDGM, Palazo Papadopoli, S. Polo 1364, Venzia, Italy

Topics:
Advanced technology and applications, sensors and materials, thermal non-destructive-testing, applications to works of art, buildings monitoring and maintenance, thermofluid dynamics, environment, standards

Language: English

Information:
A.M.Felgentreff, Fond.G.Ronchi-Firenze
P.G.Bison, CNR-ITEF, corso Stati Uniti, 4
35127, Padova, Italy
Tel. + 39 49 829 5735, Fax + 39 49 829 5728
E-mail: 5AITA.abstract@itef.pd.it
Webpage: http.// www.itef.pd.cnr.it/5AITA

13-16. October, 1999

21st Annual International Conference of the IEEE Engineering in Medicine and Biology Society in conjunction with Annual Fall Meeting of the Biomedical Engineering Society

Venue:
Hyatt Regency Atlanta, Peachtree Center, Atlanta, Georgia

*Information:*http://bmes-embs99.gatech.edu

13.November, 1999

Annual Meeting of the German Society of Thermology in Leipzig

Instructional Course for Thermographers in Bad Liebenwerda

Information:
Dr.J.-M.Engel
Chefarzt der Rheumaklinik Bad Liebenwerda,
Dresdenerstr 9, 04924 Bad Liebenwerda
Tel:+49 35341901160 Fax: +49 35341 90 27 05
E-mail: rheumamike@iname.com

2000

3.-5.August, 2000

20th Annual Meeting of the German Society of Thermology with International Participation in Celle

G.Bergmann Award for Thermology 2000

Information:
Dr.J.-M.Engel
Chefarzt der Rheumaklinik Bad Liebenwerda,
Dresdenerstr 9, 04924 Bad Liebenwerda
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