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Does thermal imaging provide extra information in patients suffering from headache ?

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Introduction

Primary headache disorders are now regarded as many discrete entities, although the view that primary headache disorders is a continuum of which each is part, is still a not uncommon idea of some headache experts (1). However, the international classification of headache disorders available since 1988 in the first version contributed a lot to the definition and understanding of headache disorders. The second edition of this classification is based on evidence that slightly different symptoms of distinct disorders are caused by a different pathophysiology (2) . This is definitely true for the primary headache forms classified with the code 1. migraine and code 3: cluster headache and other trigeminal cephalgias.

Pathophysiological models of migraine

Big progress has been made in the last 50 years in understanding the pathophysiology of migraine and other primary headaches. The vascular hypothesis of migraine developed by Wolff in the 1930s and 1940s proposed that migraine was simply a vasospastic disorder, initiated by vasoconstriction in the cranial vasculature (3). In 1969, Heyck suggested that opening of the cranial arteriovenous anastomoses, which is reflected by a sudden reduction in the difference between arterial and jugular venous blood oxygen saturation, characterizes the onset of a migraine attack. Some animal models for migraine are based on the view that cranial extracerebral vasodilatation is an integral part of the pathophysiology of migraine. The involvement of arteriovenous anastomoses in the primary headache migraine is mainly based on the findings that 1.. antimigraine agents decrease carotid blood flow by a vasoconstrictor action exclusively on arteriovenous anastomoses; 2. during migraine, the oxygen saturation difference between arterial and jugular venous blood decreases and this is normalised after treatment-induced or spontaneous alleviation of the attack (5). Pain is generated in this model due to the increased vascular pulsation which may activate mechanical receptors within the vessel wall. This would, release neuropeptides, mainly calcitonin gene-related peptide (CGRP) from the perivascular nerves which may ultimately cause pain and other associated symptoms Lance stated in 1970 (6) that "the present of migraine is that of an hereditary vascular instability which renders the individual susceptible to alteration in the level of humoral vasoactive substances, particularly serotonin, which can be in turn affected by a variety of circumstances". Consequently he used infrared thermography for research in the vascular disorder migraine.

Another phenomenon associated with changes in cerebral bloodflow goes back to the animal experiments of the the Brazilian physiologist Leão (3). He observed that the application of noxious stimulus on to the exposed cerebral cortex of an animal depressed the electrical activity at the point of application and that over time this depression spread in a wave to adjacent areas of the cortex. This phenomenon known as cortical spreading depression (CSD). CSD begins with a brief wave of excitation, followed by a prolonged period of neuronal depression, which is associated with disturbances in nerve cell metabolism. Coupled with this electrical phenomenon are cerebral blood flow (CBF) changes which consisted of four phases: a brief hypope r-fusion before the direct current (DC) shift; a marked CBF rise during the DC shift; followed by a smaller, but protracted increase of CBF; and a prolonged CBF reduction, the oligemia..(7). Two magnetic resonance imaging studies may be used as strong arguments, that CSD and the associated changes of CBF are the physiological processes underlying the aura and other prodromal symptoms of migraine patients (8,9).

However, the current understanding of migraine (10) favours a different pathogenesis of migraine. There is agreement with the relationship between aura and cortical spreading depression and the occurence of cerebral blood flow is not denied. The main concern is the mechanism of pain generation in migraine and other primary headaches which can not fully explained by solely vascular changes. Three candidates may be involved in migraine pain: the cranial blood vessels, the trigeminal innervation of the vessels, and the reflex connections of the trigeminal system with the cranial parasympathetic outflow. As the substance of the brain is insensate due to the lack of pain fibers; pain can be generated by large cranial vessels, proximal intracranial vessels, or by the dura mater. These vessels are innervated by branches of the ophthalmic division of the trigeminal nerve, whereas the structures of the posterior fossa are innervated by branches of the C_2 nerve roots. The involvement of the first branch of the trigeminal nerve and the overlap with the innervation area of the first two spinal nerves explain the common distribution of migraine pain over the frontal and temporal regions. In migraine patients it seems very likely, that activation of the brainstem observed by functional imaging is involved in the pain process in a permissive or triggering manner rather than simply as a response to nociception in the ophthalmic devision of the trigeminal nerve (11). The pain may be a combination of an altered perception as a result of peripheral or central sensitation of craniovascular input that is not usually painful (12) and the activation of feed-forward neurovascular dilator mechanism that is functionally specific for the first division of the trigeminal nerve.

It is also clear, that a number of neuropeptides is involved in the pathomechanism of primary headaches. Calcitonin-gene-related-peptide (CGRP) and substance P (SP) play a major role in the pathogenetic process of migraine. The function of CRGP as a strong vasodilator and of SP as a compound inducing extravasation and the interaction of both mediators to promote neurogenic inflammation seems to be similar in cerebral blood vessels as observed in the skin (13).

Thermography and Headache Research

Wood recorded thermal images of the face thermography in the mid of the nineteensixties for the assessment of cerebrovascular disease (14,15), but Lance was probably the first who used this technique in headache patients (6). He reported the influence of intramuscular reserpine and , intravenous serotonin on the facial thermogram. The effect of serotonin injected in the external carotid artery was documented with thermography and angiograms recorded 2 minutes after the injection. He also showed a low temperature on the affected side of the forehead in 80% of patients with acute migraine attacks.

After this first thermographic headache reports (6,16), few other papers appeared in the nineteenseventies. The pioneer of facial thermography published a paper on cluster headache (17) and Kudrow showed that higher temperatures were correlated with increased blood flow velocities measured by Doppler flow in patients sucessfully treated for cluster headache (18). A series of case reports of patients suffering from various kinds of headache and facial pains were published from Liverpool (19). Spierings quotes three papers in which thermography was applied in headache patients, but unfortunately with unclear description of the methods used. Therefore, pooled data from thermography could not be compared with the results of other techniques which have been measured hemodynamic changes in patients with vascular headache (20). A study from Italy found asymmetric facial temperature distribution in 58 % of patients during migraine attack and in 15% between attacks. More frequently than thermal asymmetry they observed a.hot spot at the internal angle of the orbita (21).

The highest interest for thermal imaging as a research tool for headache investigations wasiduring the eighties of the 20th century. Drummond and Lance concluded from thermographic findings on the contribution of dilatation of the superficial temporal artery and its branches to pain generation in migraine headache (22). Kudrow described a typical thermal pattern in patients suffering from cluster headache (23) He described two warm vertical lines contra-l ateral to the painful side, mainly in the interval between the pain attacks. Drummond and Lance described the thermal pattern in cluster headache as an area of low temperature in the affected orbital region, which may spread above and below the eye, down the nose, and to the affected temple in some patients (24) . Inhalation of 100% oxygen reduced or abolished cluster pain in 22 of 25 patients, and temperature asymmetry then disappeared. The same authors reported the thermographic findings of .186 patients during 209 separate attacks of headache affecting the anterior part of the head (25). The analysis of thermal imaging did not obtain a clear relationship between clinical symptoms and temperature changes. Throbbing headaches were associated with low temperatures over the affected fronto-te mporal region and cheek. In addition, the supra- orbital region was cooler on the affected side in patients who felt nauseated, while the opposite was observed in patients who had vomited. Thermal asymmetry in other regions was unrelated to clinical diagnosis, symptoms, severity or time course of headache. De Marinis et al induced headche with histamine in 12 healthy controls and 37 patients who had surgical treatment for trigeminal neuralgia.(26). Smaller changes of skin temperature were observed during the induced headache on the operated side than on the sied of undisturbed trigeminal nerve The authors interpreted the decreased vasomotor response on the operated side as possible pathogenetic relationship between vasomotor response and perception of headache Drummond reported temperature changes in case of chronic paroxysmal hemi-c rania which have been similar to the findings in cluster headache i. e. the temperature over the frontotemporal region was lower on the habitually-affected left side by 0.5°C, but cooler by 1°C from the cheek (27). Another case reported the treatment effect of repeted stellate ganglion blocks in a patient posttraumatic dys-au tonomic headache (28). A retrospective study on ther- mograms of 120 consecutive patients of a headache clinic found temperature asymmetries in 100% of patients with cluster headache and in 64% of migraine patients. A cold nose was a predominant finding in two thirds of migraine patients, but only in 18% of sufferers from cluster headache (29).

In 1986 a paper from Swerdlow and Dieter was the onset of the discussion on the validity of the "cold patch" in chronic headache (30). An associated editorial speculated about the utilty of thermography as a marker for vascular headache (31). Swerdlow and Dieter concluded from their statistical analysis of thermograms from 275 patients and 45 controls without headache, that vascular headache patients displayed a significantly greater number of "cold patches" than did normal individuals, or patients having secondary headaches. Mixed headaches involving a vascular component also displayed a significantly greater number of "cold patches," as did cluster disorders and post-traumatic headaches.

Swerdlow and Dieter reported thermal patterns in the posterior cervical-thoracic region from 30 headache patients randomly selected from a total patient sample of 438 (32). These subjects were followed for 5 months to investigate the persistence of three predominate patterns in the cervical-thoracic region of the back. The authors concluded that the temperature distribution over the upper back may be consistent over time, but that patterns on cervico-thoracic region fluctuate and do not correlate with chronic headaches. Drummond studied scalp tenderness in 102 patients with headache and 35 nonheadache control subjects

(33). Pressure-pain threshold at the site of unilateral headache was unrelated to thermographic findings However, tenderness in the occiput and neck was greater in 17 patients with low temperatures over the symptomatic frontotemporal region. Swerdlow and Dieter investigated the effect of hyperoxia on the temperature distribution of the forehead of headache 30 patients patients and 20 controls (34). The study demonstrated ly that a significant portion of the migraine headache population investigated exhibited a paradoxical response to hyperoxia which resulted in vasodilatation. The response to hyperoxia did not differ if the patient was experiencing a headache, nor did oxygen significantly reduce pain. Hyperoxia increased migraine "cold patch" size. Regardless of temperature fluctuations, facial patterns remained stable across conditions. S Govindan, who had stimulated Swerdlow´s study on hyperoxia, used the oxgen inhalation (35) and hypercarbia (36, 37) to increase the temperature response to antimigraine drugs or to enhance the vascular reactivity in patient with narcolepsy. (37).

The discussion on “cold patches” was stimulated by a paper by Dalla Volta and Anzola (38). The authors reported that prior to treatment, eighteen from 22 vascular headache patients presented with a "cold patch" in the external carotid territory, ipsilateral to the prevailing side of pain. After six months of treatment the "cold patch" had disappeared or was attenuated in all the patients, who had clinical improvement. Swerdlow and Dieter, who had the opinion that the thermal pattern of the forehead is stable over the time, were concerned about these results from Italy and assumed that poor standards in conducting thie study might have caused these findings (39). Subsequently they published a study, which indicates that in migraine patients with improved condition after treatment 46.7% of subjects exhibited an increase in cold patch size, 40% of cold patches remained stable, 6.7% of cold patches reduced in size, and zero cold patches disappeared with successful treatment (40). Within the group with worsend condition 20% of cold patches decreased in size, 40% increased in size, and 40% remained stable. Swerdlow and Dieter concluded from their findings, that vascular cold patch is independent of treatment effects and a permanent element of a vascular headache sufferer's facial thermal pattern.

The answer of Dalla Volta´s group was a report on a sample of 246 consecutive migraine patients (41). Among the 136 patients who experienced complete or substantial relief from headache the cold patch disappeared or markedly reduced size in 85% of the cases. In the 46 patients with partial relief the thermogram showed an improved pattern in 48% of patients, characterised by smaller hot patches compared to extent prior to treatment. No clinical improvement was observed in 24 patients with unchanged thermal images in 85% of cases. Finally, swerdlow and Dieter accepted, that thermal imaging can be used as outcome measure in headache patients (42) as proposed by Dalla Volta (38, 1), Govindan (35,36,37) and Drummond (24). Drummond reported a case series of nine patients with atypical facial pain whose thermograms indicated that vascular changes accompany a- typical facial pain in at least 50% of cases (43).

The number of publications on thermal imaging in headche patients decreased rapidly since 1990. Mongini et al were interested in the thermal image of cranio-facial pain. They used a clenching test to increase temperature asymmetry caused by tense muscles (44). This group showed also that thermal imaging can be used sucessfully as outcome measure in an analgetic drug trial (45) The responsiveness of thermography to drug effects was also shown in two trial applying sumatriptan in migraine patients (46,47). A retrospective study including thermograms from 993 patients with various headache found .abnormal thermograms in 855 patients (86.1%) characterized by low temperatures in the supraorbital region (48). The most recent thermographic headache publication closes the circle as this is like the first publication by Lance a case report with unknown impact for the diagnosis or management of patients (49).

Headache-Thermography in the current issue

In this issue of Thermology international appear three papers dealing with thermal imaging in patients suffering from headache. Srini Govindan presents two case reports. In one patient the effects of betablocker medication becomes visible by the help of hyperoxia.(50). The second case demonstrates clearly, that the vasconstrictive effect can be imaged by infrared thermography (51). The third paper evaluates the diagnostic utility of thermal imaging for headache in children (52). Headache in children is a difficult issue due to less clear diagnostic criteria. This publication from the Pediatric Neurology Department of the University Hospital in Katowice, Poland, provides evidence that different thermal pattern exist in children with various forms of headache. Perhaps, this focus on thermal imaging in headaches may stimulate further research in this field.

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Imaging the Effect of Betablocker in Migraine

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SUMMARY

The objective of this case report is to describe the capacity of infrared thermography to image the effect of Betablocker on the extracranial/ facial vasomotor response to hyperoxia in a migraine patient. The thermal image of the forehead of a female migraine patient was not altered after hyperoxia without betablocker medication, but showed normal thermal response to the oxgen challenge after intake of 160mg propanol. The mechanisms of vascular control in migraine and the modification of vascular tone by drugs is discussed in relation to changes of skin temperature.

Key Words: hyperoxia, migraine, forehead blood flow, skin temperature

DIE BILDHAFTE DARSTELLUNG DER WIRKUNG EINES BETABLOCKERS BEI MIGRÄNE

Der Zweck dieses Fallberichts ist es die Fähigkeit der Infrarot-Thermographie darzustellen, die Wirkung eines Betablockers auf die extrakraniale Gefäßantwort im Gesicht eines Migränepatienten bei Einatmen reinen Sauerstoffs bildhaft darzustellen. Das Wärmebild der Stirnregion einer Migränepatientin zeigte sich ohne Betablockermedikation bei Sauerstoffgabe unverändert, während die Hyperoxiämie nach Einnahme von 160mg Propranol zu einer typischen Temperaturreaktion führte. Die Mechanismen der vaskulären Kontrolle bei Migränepatienten und die Beeinflussung des Gefäßtonus durch Medikamente werden im Zusammenhang mit Veränderungen der Hauttemperatur diskutiert.

Schlüsselwörter: Hyperoxiämie, Migräne, Durchblutung der Stirn, Hauttemperatur

Thermologie international 2006, 16: 49-52

Abbreviations

$TcPO_2$ = Transcutaneous partial oxygen pressure

AVA'S = Arteriovenous anatomoses.

CGRP = Calcitonin Gene Related Peptide.

Introduction

Colour of the skin both in the visual and infrared spectrum can be correlated with the physiology of hemodynamic changes in skin bloodflow. The skin colour has been attributed to changes in the dermal venous plexuses [1]. Visual inspection of the face during headache has provided us with identification of patients looking pale at the height of a migraine headache and the flushed appearance of some patients with cluster headache led to the descriptive term "red migraine". During Migraine headache, the skin temperature was lower on the affected side by about 1° C. The reduction of skin temperature on the side of migraine headache, despite of dilatation of the extracranial arteries, indicates the blood is shunted away from the skin during the attack [2]. In migraine patients extracranial vascular changes have been imaged with facial thermography [3, 4]. Mathew and Alvarez reported asymmetrical temperature pattern in non-headache phase as well the headache phase of migraine, the incidence of asymmetry is slightly higher during the headache phase [5]. They attributed the temperature changes to arteriovenous shunting.

The response to pharmacological challenges in determining changes in regional blood flow may be altered in particular diseases and also under medication. The following case report illustrates the altered response to hypoxia in a migraine patient and the re-establishing of normal response to this challenge by application of propranol.

Case history

The patient reported, is a 36 year old white female, height 177cm, weight 75 kg, mother of two children. She had hysterectomy for endometriosis with partial oophorectomy at age 30, but was not on hormone substitution. There is no history of hypertension, diabetes mellitus, or malignancy, and the patient is a non smoker. She became symptomatic with migraine headaches after hysterectomy. Her symptoms have been mostly left sided, behind the left eye, with occational left facial numbness. Pain attacks can last up to three days. Headache is throbbing with nausea, vomiting, photophobia, blurred vision and disabling in nature requiring emergency room visits. She tried medication with amitriptyline and Verapamil with no significant long term benefit. Sumitriptan helped but was discontinued due to side effects. Medical and neurological examination was normal. Laboratory testing for blood count, T4, sed rate, ANA, EEG, CT and MRI of the brain, cerebral arteriogram were normal. Betablocker propranolol 160 mg gave moderate relief.

Methodology

On the day of the testing patient was instructed not to apply skin lotion, not to smoke, no physical therapy or sun tan for 48 hours, no vasoactive drugs for 24 hours and no coffee or meals for 4 hours before testing. The patient was comfortably seated in a temperature (21 ± 1°C) and humidity controlled draft free thermography laboratory. 20 minutes were allowed for the patient to adjust to laboratory temperature. The patient did not have any sunburn, sinus infection, fever or trauma to the area of study. A site was prepared for the transcutaneous oxygen sensor, using an alcohol rub.

The portable transcutaneous oxygen sensor was attached to the infraclavicular region with the patient in a sitting position. Baseline values were recorded for transcutaneous oxygen (in $TcPO_2$ mm Hg). AGA Model 782, AGEMA Infrared Systems was used, the thermographic display unit's thermal range was set at 0.5 °C. The distance between the patient and the camera was maintained constant through out the study. The oxygen procedure was explained to alleviate any anxiety or concerns the patient may have before starting the thermography testing.

Nasal compression was applied with a disposable nasal clip, after which the mouthpiece was fitted. The oxygen tank was set for an initial reading between 500 and 4000 PSI. The oxygen tank was connected via a corrugated tubing and a Trach "T" adaptor to the mouthpiece. The Puritan Flow Meter was adjusted to 15 litres per minute of 100% oxygen. At the end of five minutes the mouthpiece and the nasal clip were removed. At the end of the study the patient was asked about side-effects, headaches, paresthesias and about possible improvement of symptoms [6].

Pre and post hyperoxia facial thermograms were carried out before and after betablocker application. The Post Betablocker study was done at the half – life of propranolol, that is three hours [7]. The patient had mild to moderate headache during thermography..

Results

In our laboratory the change in thermal image as a response to hyperoxia was usually observed with TcO_2 increase from baseline by 150% after 100% oxygen inhalation for five minutes.

The "Pre Betablocker- Pre Hyperoxia" study showed an asymmetrical temperature distribution at the forehead (fig.1a).

The thermal image "Pre Betablocker- Post Hyperoxia" obtained absence of decrease in skin temperature which may caused by vasoconstriction to hyperoxia (fig. 1b).

The Post Betablocker – Pre hyperoxia study showed an asymmetrical temperature distribution at the forehead sim-

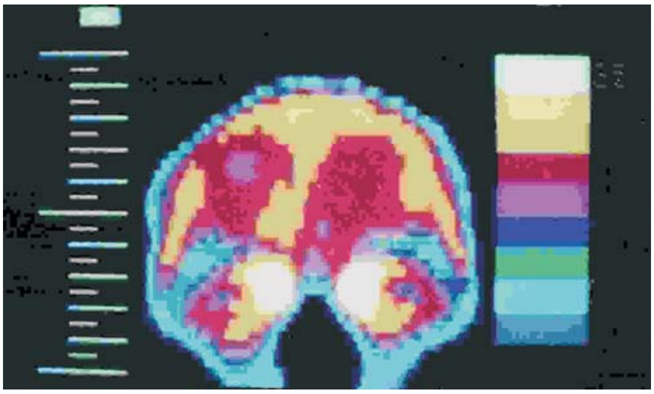

Figure 1a
Pre Betablocker and Pre hyperoxia.
Temperature scale: $35^{\circ 0}$ C at the top of the temperature scale, Each colour change at 0.5^{0}C of temperature.

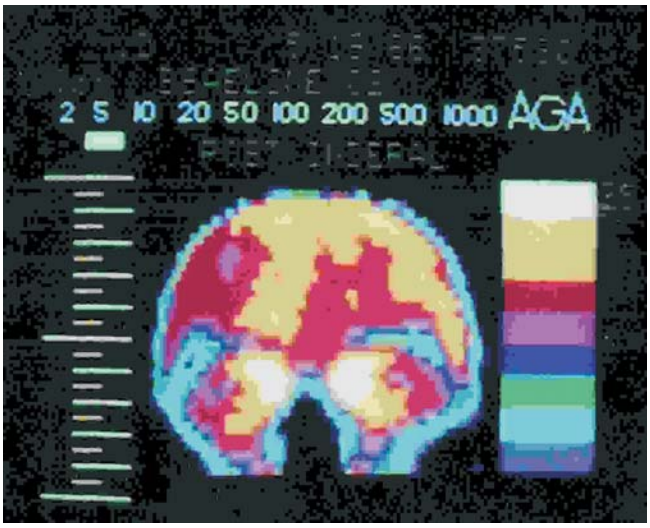

Figure 1b
Pre Betablocker and Post hyperoxia.

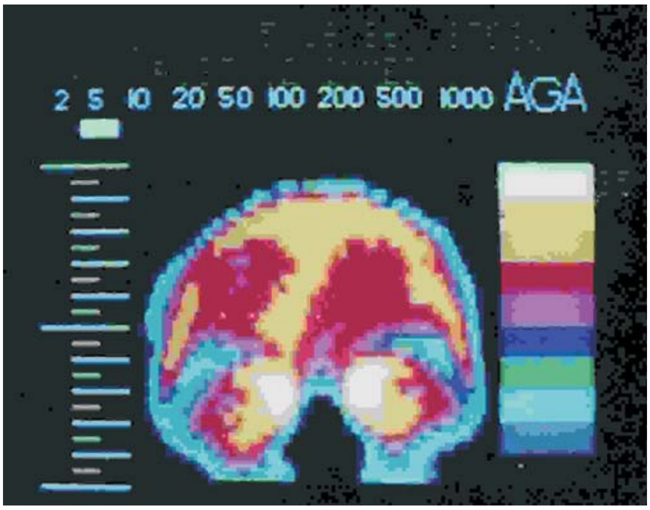

Figure 1c
Post Betablocker and Pre hyperoxia

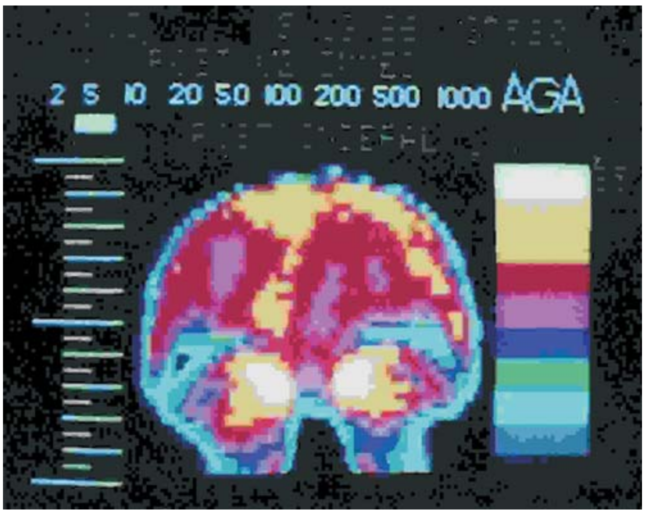

Figure 1d
Post Betablocker. And Post hyperoxia

ilar to the thermal image recorded previous to hyperoxia, but without betablocker (fig. 1c). In the image "Post Hyperoxia- Post Betablocker" the expected decrease in skin temperature was detected as vasoconstriction is the normal response to the hyperoxia challenge (fig. 1d).

Table 1
Temperature changes during the investigation

History	Forehead Temp. C	Remarks
Pre Betablocker	34.0	
Pre Betablocker & Post Hyperoxia	34.0	No temperature change
Post Betablocker	34.5	
Post Betablocker & Post Hyperoxia	33.0	Decrease of temperature noted

Discussion

Hyperoxia in normal controls decreases the temperature of the face due to vasoconstriction and or changes in the arteriovenous / microvasular shunting [8]. Induced hyperoxia allows us to image vasomotor reactivity/ capacitance ie, vasoconstriction (normal response), vasomotor paralysis (absence of response) and vasodilatation (paradoxical response). Migraine patients have both intra and extra cranial vasomotor abnormalities. Testing vasomotor responses during hyperoxia is safe, clinically helpful, and demonstrates altered vasomotion [9]. Changes in vasomotion towards normal ie., vasoconstriction to a vasoconstrictor stimuli (eg, hyperoxia) would be considered as normalization or stabilization of vasomotion and can be correlated with the effect of the migraine drug on vasomotion and clinical response. Hyperoxia causes changes in neuropeptide similar to antimigraine drug sumitriptan by normalizing level of CGRP measured in the blood from external jugular vein during the attack of cluster headache [10].

De Castro [11] observed by binocular microscopy that when arterivenous anatomoses were open there was rapid blood flow through the veins while closing of arterivenous anatomoses led to sluggish venous flow. He also observed variation in the lumen of arteriovenous anastomoses under stimulation with oxygen, carbondioxide and epinephrine. Rapid flow of blood happens when arterivenous anatomoses are open. Pale and Red appearance may relate to size and neurochemical control of vascular system of the skin involved in particular clinical state.

Della Volta [12] has indicated thermoghaphy can be helpful in understanding pathophysiology of migraine. The alteration in extracranial blood flow depends on pre- existing vasomotor tone and the vasomotor capacitance of the individual[13]. The dynamic nature of extracranial vasomotion appears to be predictable within the physiological limits of vasoconstriction and vasodilation. The dynamic thermography method used to image drug effect in this case meets the extracranial microcirculation measurement criteria [14,15], by its ability to 1) Image and monitor the primary vasoactive response of the individual, based on pre-existing vasomotor tone, 2) To evaluate the clinically vasomotor reactivity within the biological limits of vasomotion i.e.,Vasoconstriction/Vasodilation, 3) Provide the methodology to document the effect of agonistic and antagonistic drugs on the extracranial / facial blood flow vasomotion under the regional control of Trigeminovascular System, 4) Help to understand the control processes that may occur in response to dynamic conditions by using a protocol involving changing rather than static conditions such as superimposed vasomotor and pharmacological challenges and 5) Visualize blood flow changes in real time.

Normalization of thermal asymmetries following drug treatment and relationship of facial thermal patterns with central sensitization have been studied by Della Volta. Hyperoxia challenge gives us an opportunity to image the effect of antimigraine drug on microvascular vasomotor state. This patient was on Betablocker Propranolol, which helped her headaches. The thermograms showed the patient had absence of normal vasoconstriction to hyperoxia challenge before Betablocker treatment. After Betablocker the vasomotor response improved ie, vasoconstriction to hyperoxia challenge. Hyperoxia increases oxygen radicals [16]. 4-HO- propranolol, a major metabolite of propranolol has potent antioxidant properties [17]. The clinical presentation during migraine may depend on the extent of the involved pathophysiology i.e., the trigeminal ganglia, the brainstem trigeminal nucleus or the thalamus [18, 19]. The vasomotor testing with hyperoxia allows us to evaluate the status of the vasomotor function/ capacitance. The tendency to normalize the vasomotor response may indicate the effect of the drug to improve the vasomotor abnormality [20, 21].

Conclusion

The methodology presented in this paper allows us to image the effect of the drug on the vascular bed that is under control of the trigeminal vasomotor system. This has clinical and research implications.

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Thermographic examination in children with headache

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SUMMARY

Headache is one of the most common human experiences and medical complaints of civilised humans.

The aim of the study was the evaluation of application of thermography for children with headache and to describe patterns of typical temperature distribution in idiopathic (primary) and symptomatic headache.

Study population consisted of 51 children with headache and a control group of 20 healthy children. For thermographic evaluation we used the ThermaCam PM 595 device. Standardised clinical procedures were used. Qualitative and quantitative facial image analysis was performed.

Results: The thermal image of the face in healthy children shows s symmetrical temperature distribution witha cold nose, but a warm mouth and warm eyes. Thermographic abnormalities were in migraine patients predominately on the forehead, in children with tension type headache at back of head and neck, in patients with temporomandibular joint (TMJ) dysfunction in the area directly and anterior to the TMJ, and in children with sinusitis in the region over the of sinuses.

Conclusions: 1.Different types of headache have a characteristic pattern of temperature distribution in thermal images. 2.Thermographic examination may be very useful for the differentiation of the headache type.

Key words: Headache, thermography, children

THERMOGRAPHISCHE UNTERSUCHUNG BEI KINDERN MIT KOPFSCHMERZEN

Kopfschmerzen gehören zu den häufigsten Gesundheitsbeschwerden der zivilisierten Menschen.Das Ziel der vorliegenden Studie war es einerseits, die Brauchbarkeit der Infrarot-Thermographie für die Beurteilung von Kindern mit Kopschmerzen zu ergründen und andererseits typische Temperaturverteilungen bei primären und sekundären Kopfschmerzformen zu erfassen.

Die untersuchte Gruppe umfasste 51 Kinder mit Kopfschmerzen und 20 gesunde Kontrollen. Für die thermographische Untersuchung wurde eine ThermaCam PM 595 verwendet. Standardisierte klinische Prozeduren wurden angewendet und die Wärmebilder des Gesichtes qualitativ und quantitativn ausgewertet.

Ergebnisse: Das typische Wärmebild des Gesichtes eines gesunden Kindes zeigt eine symmetrische Temperaturverteilung mit kalter Nase, warmen Mund und warmer Augenregion. Bei Kindern mit Migräne fanden sich thermographische Auffälligkeiten vorwiegend an der Stirn, bei Kindern mit Spannungskopfschmerz zeigten sich auffällige Befunde am Hinterkopf und Nacken. Bei Beschwerden im Kiefergelenksbereich zeigten sich Veränderungen vor und unmittelbar über dem Kiefergelenk, während bei Sinusitis die Region über dem Sinuses verändert war.

Schlussfolgerungen: 1.) Unterschiedliche Kofschmerzformen zeigen jeweils typischeTemperaturverteilungsmuster im Wärmebild. 2.) Die thermograpphisch Untersuchung kann in der Unterscheidung des Kopfschmerzes sehr hilfreich sein.

Key words: Kopfschmerzen, Thermographie, Kinder

Thermology international 2006, 16: 51-57

Abbreviations

EEG – electroencephalography
THV – thermography
MRI – magnetic resonance image
CT – computer tomography
SPECT – single photon computer tomography
TMJ – temporo-mandibular joint
TTH - tension type headache
Occ+n - occipital and neck
PTH - posttraumatic headache
MH – mixed headache
TMJD – temporo-mandibular joint disease
ICP – intracranial pressure

Introduction

Headache is one of the most common human experiences and medical complaints of civilised humans. 40% of children have headache by the age of 7 years and 75% have cephalalgia by the age of 15. Children with both acute and chronic headache are often seen by paediatricians and paediatric neurologists.The majority of headache types (60 – 80% of headache children) are easily identified applying standarized diagnostic criteria. Diagnostic decision is difficult in a small percentage of patients only. The diagnosis of headaches in children is based on a complete history, a physical and neurological examination, selected screening laboratory tests and sometimes on neuro-imaging. Children's headache drawing and various questionnaires are aids for the diagnosis of headache type. The process of headache diagnosis is often arduous and depends on the clinician's experience and the avoidance of subjective biases. (1,2,3,4)

Infrared thermal imaging (medical thermography) is based on the ability to image the heat emission of the human body. Abnormalities such as inflammation, malignancies, disturbances of blood circulating and in nerves conduction are vusible in infrared images. Heat emission from the human face may be visualised using noncontact infrared systems. This imaging method is non-ionizing, non-invasive and painless. This is extremely important in children. Thermography was used for diagnosis of headache in adults since 1970 (5,6,7, 8)

In healthy human subjects the thermal pattern of the face is symmetrical with a cold nose, warm orbits and mouth. Abnormal facial thermograms can be seen in myofascial pain syndromes, myositis, TMJ diseases and sinusitis (9,10, 11).

The aim of the study

The aim of the study was the evaluation of application of thermography for children with headache and to describe patterns of typical temperature distribution in idiopathic (primary) and symptomatic headache.

Methods

Study population

Study population consisted of 51 children (30 male, 21 female) aged 6 – 18 years, hospitalised in the Department of Paediatrics and Child Neurology, Medical University of Silesia Katowice.

They were all examined using a comprehensive diagnostic protocol including history, physical examination, neurological examination, ENT examination, laboratory testing, Transcranial Doppler Sonography, EEG, X-ray, thermography (THV), psychological tests, fundoscopic examination amd imaging studies (CT and/or MIR). All patients completed also a painquestionnaire .

Control group

For comparison of THV results we evaluated 20 healthy children (11 male, 9 female) aged 6 – 18 years (the mean age was 12,3 years) without history of headache in the previous 2 years.

Thermal imaging

For thermographic evaluation we used the ThermaCam PM 595 device produced by FLIR SYSTEMS. The examinations were carried out at constant environmental temperature (20-22°C) and humidity (40-50%) following the guide- line of the International Academy of Thermology.

Standardised clinical procedures were used: the face was clear of make-up, hair pulled back from the face with an elastic head band, patient seated in a relaxed position for a minimum pf 15 min to achieve a stable physiological state. Thermal adaptation was minimum 20 min before examination. All patients were imaged prior to the main meal.

Qualitative and quantitative facial image analysis was performed for the face in the frontal view, for left and right lateral views and for the back of the head and neck (fig 1)

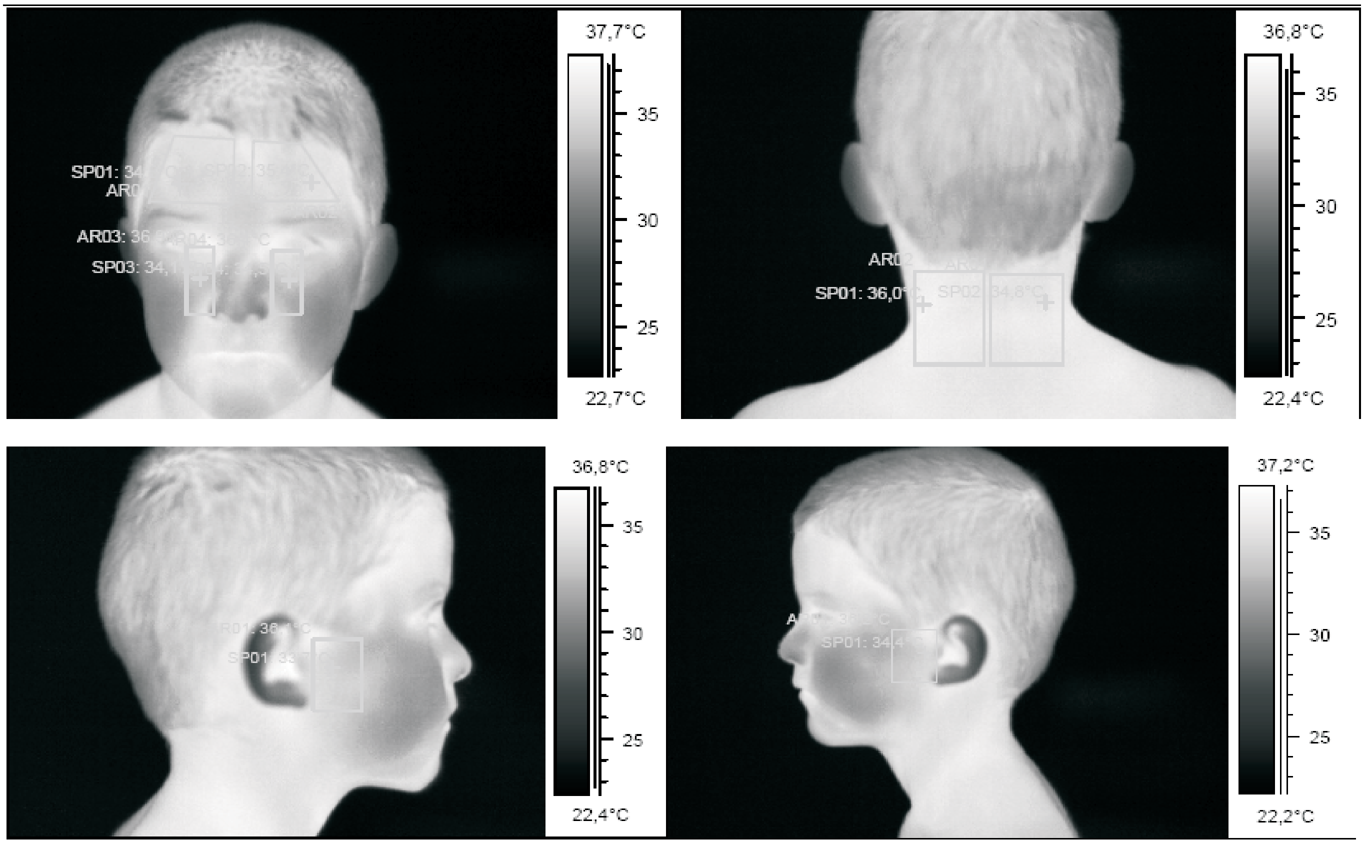

Figure 1.
Localization of areas of interest

Methods of image characterisation included :

1.spot temperature measurements

2. Difference (Δt) between contralateral spot temperature

3.mean temperature of anatomical regions

4.Δt between mean temperatures of contralateral anatomical regions

The study protocol was approved by the local ethics committee.

Results

The thermal image of the face of healthy children (control group) shows symmetrical temperature distribution with a cold nose, a warm mouth and warm eye region.. There are no hot or cold spots in the paranasal region, forehead, temples , in the region of TMJ and the back of the head and neck. Δt between contralateral regions of interest was <0,5°C. (fig. 2)

Table 1 contains patients' data, localisation of pain, abnormalities in thermal images, first and final diagnosis.The diagnosis of type of headache was based on the criteria proposed by the Headache Classification Committee of the International Headache Society (ICHD II). For bias reduction, the thermographer was blinded for patients' history and therapy. THV was performed as the first step in the diagnostic process.

Based on the thermographer´s findings, the clinicians changed diagnoses in several children.

Six patients presented with normal thermal images. Their history was anlized again. Patient 3 with migraine had headache one month prior to the THV examination, but the psychologist suggested aggravation. Patients 4 and 8 had headache one year before. It is possible that the characteristic cold patch has disappeared in a long pain-free period as this may be a time associated phenomenon.

Figure 2. Healthy boy, 15 years old
Symmetrical image without hot or cold spots

Patient 17 with TTH had headache 11 months prior to the THV examination, so he did not fulfill the ICHD II criteria for TTH. The female patient 18 had headache one week prior to THV. After psychologic and psychiatric examinations we changed diagnosis to psychogenic headache as a form of somatoform disorder. Patient 26 had headache 13 months prior to the THV investigation, he had no symptoms at the time of thermography and was labelled as healthy.

THV examinations were performed in a pain-free period spanning a time from 1 week to 1year in individual patients. In 10 patients [1, 2, 6, 8, 12, 14, 15, 21, 24, 25] thermal images were recorded during painful and in pain-free periods. However, these images lookewd very similar.

Table 2.
Localization of abnormalities in thermal images of chuildren with headache

Final diagnosis	forehead		Paranasal sinuses		TMJ		Back of head & neck	
	normal	abnormal	normal	abnormal	normal	abnormal	normal	abnormal
Migraine (n=19)	6	13					11	8
Tension type headache (n=9)	5	4					9	7
Posttraumatic headache (n=7)	2	5					5	2
TMJ dysfunction (n=8)					0	8	7	1
Sinusitis (n=9)	5	4	0	9			7	2

Table 3.
Characteristic of Δt°C = arithmetic mean between contralateral spot temperatures

Final diagnosis	forehead		Paranasal sinuses		TMJ		Back of head & neck	
	mean	SD	mean	SD	mean	SD	mean	SD
Migraine	0.82	0.27					0.89	0.27
Tension type headache	0.93	0.29					0.87	0.24
Posttraumatic headache	0.74	0.18					0.87	0.31
TMJ dysfunction					1.03	0.38		
Sinusitis	0.89	0.36	0.88	0.33				

Table 1
Comparison of pain, THV image and diagnosis

Patient	age	Sex	Localisation of pain	THV-localisation of abnormalities	Diagnosis	Final diagnosis (if changed)
1.	11y	M	head left	forhead left	migraine	
2.	10y	M	head right	occ+n.right	migraine	
3.	18y	F	head right	Normal	migraine with aura	
4.	15 y	M	head	Normal	migraine with aura	
5.	10y	M	forehead	occ+n.right	migraine	
6.	7y	F	head right	forehead+.occ+n. right	migraine	
7.	16y	F	forehead left	forehead	migraine	
8.	16y	M	forehead left	Normal	migraine with aura	
9.	13y	M	forehead+ temporal	forehead +occ+n right	migraine	
10.	14y	F	forehead left	forehead left+ occ+n right	migraine with aura	
11.	9y	M	head right	forehead l+ occ+n right	migraine	
12.	11y	M	temporal	occ+n right	migraine	
13.	11y	M	forehead right	forehead right	migraine	
14.	17y	F	forehead, temporal	forehead	migraine	
15.	14y	M	forehead, temporal	forehead	migraine	
16.	11y	F	forehead	forehead +occ+n right	migraine	
17.	16y	M	head	Normal	TTH	healthy
18.	17y	F	forehead	Normal	TTH	depression
19.	6y	F	forehead	occ.+n left	TTH	
20.	12y	M	temporal right	occ.+n right	TTH	
21.	18y	F	occipital	occ.+n left	TTH	
22.	11y	M	temporal left	occ.+n left	TTH	
23.	11y	M	parietal	parietal	TTH	
24.	13y	F	forehead right	forehead+ occ+n right	TTH	
25.	9y	M	head	forehead+ occ+n	TTH	
26.	13y	M	forehead	normal	PTH	healthy
27.	14y	F	forehead+occ. right	forehead+ occ+n right	PTH	
28.	13y	M	forehead	forehead	PTH	
29.	6y	M	forehead	forehead	PTH	
30.	8y	M	forehead	forehead+ occ+n	PTH	
31.	18y	F	forehead	forehead+ occ+n	MH	PTH
32.	13y	M	ferehead+ temporal	forehead right+ sinuses	MH	Sinusitis, migraine
33.	17y	F	forehead right	sinuses	MH	Sinusitis
34.	9y	M	head	forehead,sinuses, occ+n	MH	Sinusitis,TTH
35.	13y	M	forehead	orbits	MH	PTH
36.	18y	F	head	forehead, sin, occ+n	MH	Sinusitis,TTH
37.	11y	M	temporal left	temporal left	MH	
38.	12y	M	head	TMJ	MH	TMJD
39.	15y	M	head	TMJ+ occ+n	MH	TMJD,TTH
40.	14y	F	temporal	forehead, TMJ	MH	TMJD,migraine
41.	12y	M	forehead	TMJ,sinuses	MH	TMJD,sinusitis
42.	11y	F	head	forehead	MH	migraine
43.	14y	M	forehead	TMJ left	TMJD	
44.	16y	F	temporal	TMJ left	TMJD	
45.	11y	F	temporal left	TMJ left, occ+n left	TMJD	
46.	17y	F	head	TMJ left	TMJD	
47.	10y	F	head	TMJ left	TMJD	
48.	14y	M	forehead	sinus left+ orbits	sinusitis	
49.	7y	F	head	sinuses	sinusitis	
50.	16y	M	forehead	forehead +sinuses	sinusitis	
51.	12y	M	head	sinusitis	sinusitis	

Head - total head
Occ+n - occipital and neck
TMJ – temporo-mandibular joint
TMJD - temporo-mandibular joint disease

TTH - tension type headache
PTH - posttraumatic headache
MH – mixed headache

Table 4.
Regression logistic coefficient for THV images including the time since last pain with the Wald significant test.
(Δt between contralateral spot temperature > 0,5°C)

Final diagnosis	forehead	Paranasal sinuses	TMJ	Back of head & neck
Migraine	0.630 (NS)		-1-386 (NS)	-0.593 (NS)
Tension type headache	-2.875 (p<0,005)	-0.161 (NS)		3.256 (p<0.005)
Posttraumatic headache	0.803 (NS)			-0.287 (NS)
TMJ dysfunction	-1.203 (NS)	1.539 (NS)	2.971 (p<0.02)	-0.485 (NS)
Sinusitis	0.489 (NS)	3.851 (p<0.03)	-1.972 (NS)	-0.367 (NS)

Table 5.
Relative risk for THV images with significance logistic regression coefficient

Final diagnosis	localisation	relative risk
Sinusitis	Paranasal sinuses	47.0
Tension type headache	Back of head & neck	25.9
TMJ dysfunction	TMJ	19.5

Table 2 contains the localisation of abnormalities in thermal images and table 3 shows Δt°C, which is equal to the arithmetic mean between contralateral spot temperatures. The difference of Δt°C was higher than 0,5°C. Its range was between 0,74°C in foreheads of patients with posttraumatic headache to 1,03°C in children with TMJ disorders. For statistical analysis regression logistic coefficient was calcu- lated. Regression logistic describes the even probability for a efinite feature. In our investigation it means the liklihood of a defined disease (migraine, TTH, posttraumatic headache, TMJ disease or sinusitis) when characteristic features appeared in the .thermal image (table 4).

In migraine patients the regression logistic coefficient was highest for abnormalties found on the forehead localisation, but without statistical significance. In patients with TTH statistical significant regression coefficients were obtained for abnormalities located on the forehead and on the back of a head and neck. In children with posttraumatic headache no significant regression coefficients were found. In patientss with TMJ disorders and sinusitis, regression coefficients for abnormalities located in the related anatomical regions achieves statistical significance.

The relative risk for manifestation of subtypes of headache in patients with characteristic infrared images was also determined. (table 5) Relative risk is very high in sinusitis (47 fold) but low in migraine. It means that in a patient who has abnormal thermal image of the forehead, migraine is almost twice (1, 9) frequent than in a healthy child.

Discussion

Pathophysiology of headache is complicated because pain referred to the head arises from intracranial or extracranial structures and causes:

- arteries; large veins or venous sinuses
- the basal menin-ges
- dilatation or in-flammation of cranial vascular structures
- displacement of intracranial contents by tumor, abscesses
- increased intra-cranial pressure (ICP)
- direct pressure on cranial nerves
- contraction of the head and neck muscles
- pathologic pro-cesses outside of the brain (paranasal sinuses, eyes, teeth, and bones of the head and face)

When pain is arising from cranial circulation it is localised in the front of the head, pain originated in the posterior fossa is projected to the back of the head and neck, and occasionally to the forehead.

THV is useful objective measure for monitoring the course of headache. It has become widely accepted that patients suffering from migraine show on THV a characteristic pattern of asymmetry in the vascularisation of the forehead in the supraorbital region. Dalla Volta described the disappearance or attenuation of the “cold patch” after six months of sucessful therapy (8) In our patients we observed a “ cold patch” on the forehead in 13 of 16 abnormal images, but in 8 patients asymmetry on the back of head and neck was also detected.. Goadsby at al. stated that the involvement of the ophthalmic division of the trigeminal nerve and the overlap with structures innervated by C2 explain distribution of migraine pain over the frontal and temporal regions, and also the involvement of parietal, occipital, and high cervical regions.(13)

In previous work we found such THV patterns in patients with asymmetry in blood flow which can be detected by trancranial Doppler sonography (14). Anzola at al. suggested that the cerebral arterioles of migrainous are more likely to undergo vasoconstriction. During migraine attack „cortical spreading depression” is observed. The increased release of of neuropeptides leads to „neurogenic inflammation”(7).

Activation of the trigeminovascular system is thought to be a common pathway involved in many primary headache disorders. Activation of trigeminal neurons is known to elevate neuropeptides during migraine and TTH „neurogenic inflammation” can explain changes in thermal pattern during headache, but why these changes persist in pain-free period is not known. Neuropeptide levels in

Figure 3. Migraine
16 years old girl during pain – cold patch on left the forehead

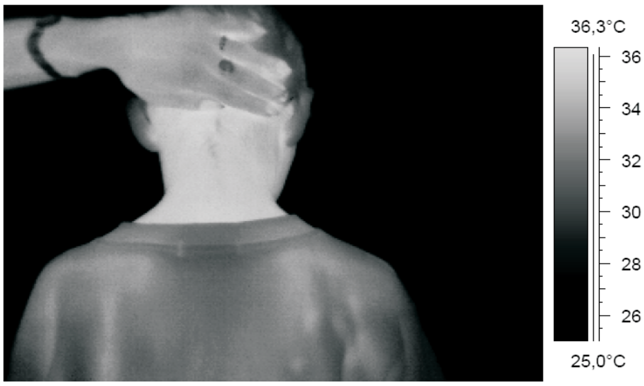

Figure 4. Tension type headache
7 years old girl – asymmetric image of the back of head and neck

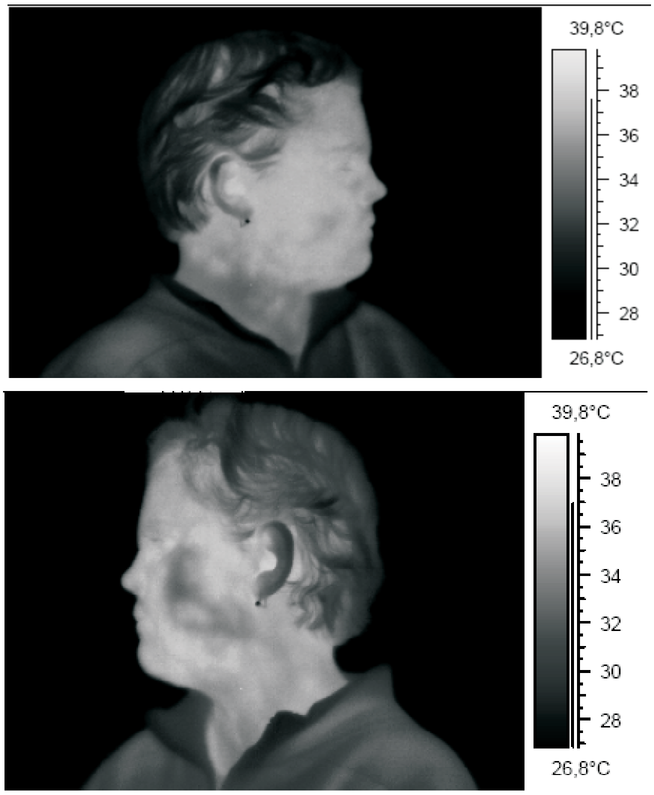

Figure 5. Left TMJ dysfunction
17 years old girl – colder region over the left TMJ

Figure 6. Sinusitis
10 years old girl – warm areas in the paranasal region, warm orbits and forehead.

pain-free period were investigated by different researchers but the results are controversial (15,16,17, 18)

Patients with TTH may present with increased tenderness of pericranial myofascial tissues and a decrease in blood in flow in muscles (m. trapezius). NO may activate and sensitise the nociceptive input from blood vessels and myofascial tissue. Sympathetically mediated vasoconstriction is seen in THV as an asymmetry image of the back head and neck with colder pain side (19,20).

In patients with posttraumatic headache disturbances of cognition, attention and short-term memory often occur. Subclinical brain alternations have been detected with functional neuroimaging such as SPECT. It can be hypothesed that in the course of cranial trauma an alternation in neurotransmitters pathways can occur and play a role in pathophysiology (21). In all, but one of our patients , abnormal thermal images were observed. This patient with traumain the previous year and without headache had normal temperature pattern. A history of head trauma and headaches within the last year is not enough to consider the trauma as possible cause of pain symptoms.

THV is widely used in diagnosing mandibular dysfunction (TMJ) in adults. Gratt at al. reported a sensitivity of 86% and specificity of 78% of THV examinations for TMJ dysfunction.(22,23,24). Headache due to TMJ diseases is often missed in differential diagnosis because many paediatricians believe that TMJ occurs only in adults. Abnormal thermograms may develop in response to vasomotor dysfunction. Such dysfunction can not be demonstrated by radiographic studies or MRI before structural changes occur. THV images rather physiology or pathophysiology than anatomy.of affected region In our study there were only 9 patients with TMJ dysfunction, but Δt between left and. right side was high (minimum temperature difference. 1,03°C). All the patients had abnormal images only in TMJ region. Thermal imaging is a easy and quick way to establish a correct diagnosis of such disease.

Relative risk which describes the likelihood how many times more the disease will appear, was highest in sinusitis, on a similarincreased level in TTH and TMJ diseases and lowest for migraine patients..

Thermographic examination is not yet part of the diagnostic protocol for chronic sinusitis. In our previous work sensitivity of THV in comparison with ENT examination was 89,7% THV versus X-ray 93,5% but ENT examination versus X-ray only 78,1%(25).

Loss of thermal symmetry of skin temperature is important finding in all the pathological states of humans (12). Gratt and Anbar had shown that in normal subjects differences in skin temperature on selected points from side-to-side is about 0,2°C and in chronic facial pain disorders the difference is greater than 0,5°C (8). The quantitative measurement is important, mainly in acute diseases. In chronic sinusitis Δt is not very high, but qualitative examination may obtain warm areas in the maxillary region at both sides. The qualitative evaluation of thermal images of a patient with chronic sinusitis must be performed by an experienced physician.

Conclusions

1. Different types of headache have a characteristic pattern in the thermal image:

- Thermal abnormalities in migraine patients were mostly on the forehead , these findings carry a relativ risk for the disease of 1.9 (fig 3).
- children with tension type headache show temperature changes on the back of head and neck with a relative risk for the disease of 25.9 (fig 4)
- The typical thermal pattern of children with temporomandibular joint (TMJ) dysfunction is located in the area directly and anterior to the TMJ with a relative risk for the disease of 19.5 (fig 5).
- Temperature changes in the skin area over the sinuses is typical for children duffering from sinusitis. This thermal pattern had the highest relative risk for the disease with a figure of 47 (fig 6)

2. THV examination may be s useful in the differentiation of the type of headache-

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Imaging the effect of Sumatriptan in Migraine treatment

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SUMMARY

Imitrex ® (Sumatriptan Succinate Injection) is used in the treatment of migraine. It has an effect on the cranial vasculature which is involved in the pathophysiology of migraine. A case is presented with thermographic documentation of changes in extra cranial microcirculation/arterio-venous shunting in the region of cranial angiosomes correlating with clinical drug effect.

Key words: Angiosomes, Migraine, Extracranial microcirculation, Imitrex ® (Sumitriptan Succinate Injection)

ABBILDUNG DER WIRKUNG VON SUMATRIPTAN IN DER MIGRÄNE-THEAPIE

Imitrex ® (Sumatriptan Succinate Injektion) wird für die Behandlung akuter Migräneanfälle eingesetzt. Das Medikament beeinflußt die Blutgefäße des Schädels, die eine Rolle in der Pathophysiology des Migräneanfalls spielen. An Hand eines Fallberichts werden thermographische Veränderungen gezeigt, die durch die Einflußnahme auf die extrakraniale Mikrzirkulation bzw arteriovenöser Anastomosen im Bereich der kranialen Angiosomen bedingt und mit der klinischen Wirkung verbunden sind.

Schlüsselwörter: Angiosom, Migräne, extrakraniale Microzirkulation, Imitrex ® (Sumitriptan Succinate Injektion)

Thermology international 2006: 16: 60-63

Abbreviations

AVA'S = Arterio-venous anatomoses.
CGRP = Calcitonin Gene Related Peptide.

Introduction

Forehead has been designated as a reference area to compare in considering ratios for interpretation of thermograms in neurological disorders [1]. In migraine the micro-cir culation shunting is extracranial. The areas of the nose showing the change is in the external carotid angiosome territory of the head. The external nose blood supply is provided by the facial branch of the external carotid artery. Blood supply to the nasal tip and the nostrils is provided by the lateral nasal branch of the facial artery, which forms an arcade on each side as it anastomoses with the columellar branches of the superior labial vessels [2]. The medial part of the forehead and proximal part of the nose supplied by the ophthalmic and internal carotid artery branches appears to have less microvascular shunting compared to the area supplied by the external carotid ie, the distal part of the nose and the lateral aspect of the face.

Mathew and Alvarez reported an asymmetrical temperature pattern in non-headache phase as well the headache phase of migraine, the incidence of asymmetry is slightly higher during the headache phase [3]. They attributed the temperature changes to arterio-venous shunting.

Dynamic Thermography meets the extracranial microcirculation measurement criteria [4,5], by its ability to document the effect of agonistic and antagonistic drugs on the extracranial blood flow under the regional control of trigeminovascular system. Internal and external carotid blood flow and pharmacological comparison of histamine receptors have been studied in animal models [6, 7]. The anatomy, physiology, pharmacology of arteriovenous anastomoses and their role in migraine shunt theory and the action of ergotamine have been addressed by Sherman [8], Heyck [9], Saxena [10], Johnston [11] and Spierings [12, 13]. During the attack of cluster headache the antimigraine drug sumatriptan and oxygen normalises level of CGRP (Calcitonin Gene Related Peptide) measured in the blood from external jugular vein [14]. Intra and extracranial vasculature are innervated by the trigeminovascular system. Vasoactive peptides are released in the extracerbral circulation of humans and cat during activation of the trigeminovascular system [15]. Works done by Lance [16], Drummond [17, 18] and Swerdlow [19] have indicated thermography can be helpful in understanding pathophysiology of migraine. Thermography can image changes in forehead cutaneous perfusion affecting vessel size of 300 um or smaller in response to nonthermal stimuli [20].

The objective of the investigation reported, is to image extracranial bloodflow using thermography before and after Imitrex ® (Sumatriptan Succinate Injection) treatment in one patient with acute attack of migraine.

Methodology

Thermal images were recorded during a moderate migraine headache before and after Imitrex ® (Sumatriptan Succinate Injection) treatment. Pre treatment baseline facial thermograms included anterior, right and left lateral views. Following treatment with Imitrex ® (Sumitriptan Succinate Injection) thermograms were started 15minutes after first injection to correlate with the half life of CGRP (Calcitonin Gene Related Peptide), the neurochemical involved in migraine. Thermograms were done at 15, 30, 45 and 60 minutes. First dose was 6mg subcutaneous injection. 1 hour after the injection patient's headache improved but he was not pain free and a second dose of Imitrex ® (Sumatriptan

Succinate Injection) 6 mg was administered. Thermograms were repeated one hour after second injection.

A FLIR A 40 infrared Camera was used with auto focus and CTherm software. The testing was done in a temperature and humidity controlled draft free laboratory. The patient was instructed to avoid application of skin lotion or smoking on the day of the thermographic investigation. No physical therapy or sun tan for 48 hours, not to have taken any triptans or ergot preparations for 48 hours before testing were other requests..

Imitrex ® (Sumatriptan Succinate Injection) is an 5 HT I D agonist approved for treatment of acute migraine. It causes vasoconstriction, an action in humans correlating with the relief of migraine. In the cat, sumitriptan selectively constricts the carotid arterio-venous anastomoses while having little effect on bloodflow or resistance in cerebral or extracerebral tissues.

Clinical History

The patient is 32 year old white male non diabetic, normotensive, euthyroid with longstanding history of disabling headaches, throbbing in nature, mostly right sided, associated with nausea, photophobia, phonophobia. No aura/visual symptoms, no paresthesias or nasal stuffiness. General medical and neurological examination, EEG and MRI of the brain with contrast were normal. He tried atenolol, lamotrigine, magnesium supplement, topiramate, Midrin® (combination of isometheptene mucate.; dichloralphenazone and acetaminophen) propranolol, amitriptyline, sertraline, fluoxetine, verapamil, rofecoxib, celecoxib, tiagabine, gabapentin, and divalproex without long lasting benefit. He stopped topiramate one week before this testing. He was not on any preventive medicine for migraine during this testing. He took no triptans for 48 hrs before test. On the day of thermograms he started with right sided headache 8 hours before the thermograms. With the first injection headache relief was from 5/10 to 1/10. Photo and Phonophobia improved from moderate to very mild. One hour after the second injection no change in headache, photo or phonophobia occurred.

Thermographic findings

The temperatures of the medial forehead area supplied by ophthalmic and internal carotid artery branches were compared to temperatures of nose and lateral aspect of the face supplied by external carotid artery branches.

Pre treatment thermograms show asymmetrical temperature pattern of the face and the nose is 4 °C cooler compared to his forehead (Figure 1A, Figure 2)).the images in Figure B to E were recorded 15, 30, 45 and 60 minutes after

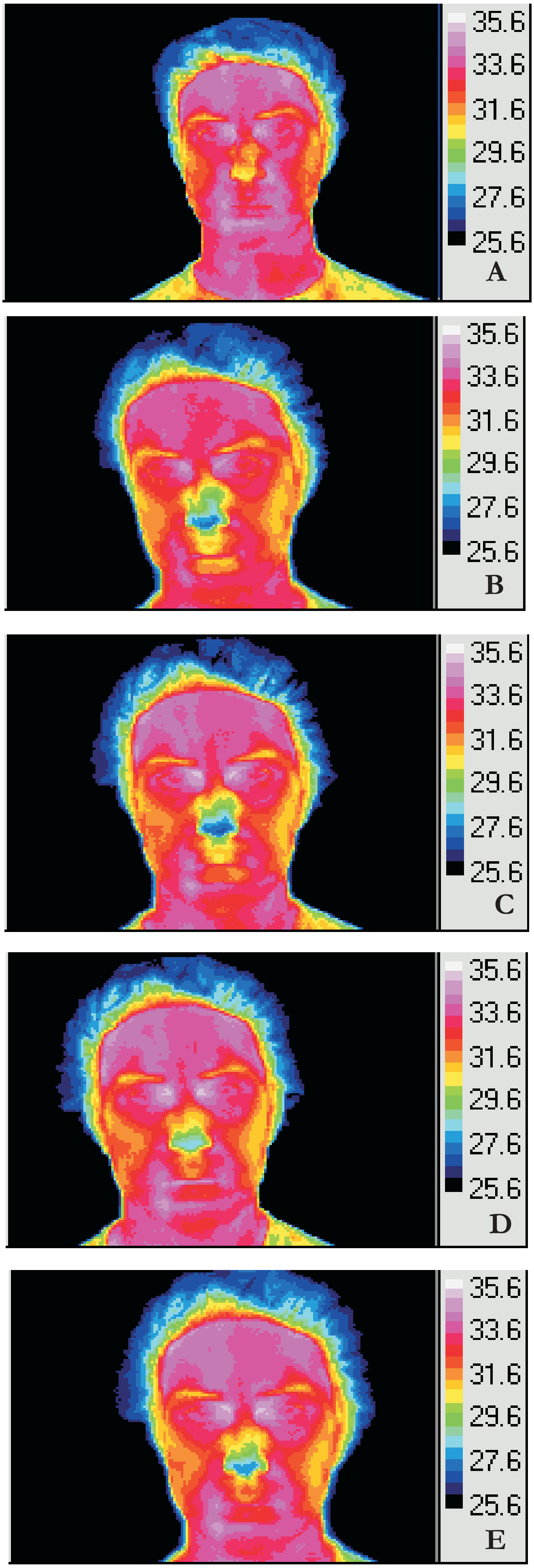

Figure 1
Top to bottom
A.) Thermal image before Sumatriptan
B) 15 minutes after injection of Sumatriptan
C) 30 minutes after injection of Sumatriptan
D) 45 minutes after injection of Sumatriptan
E) 60 minutes after injection of Sumatriptan

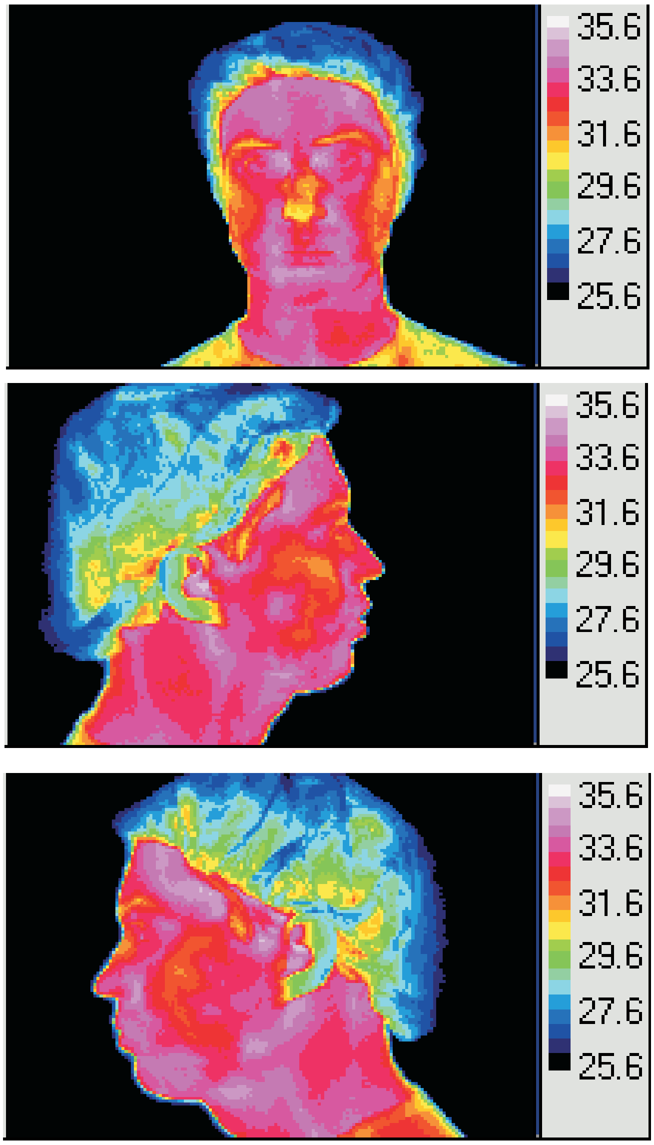

Figure 2
Front view and lateral views of the face prior to the injection of sumatriptan

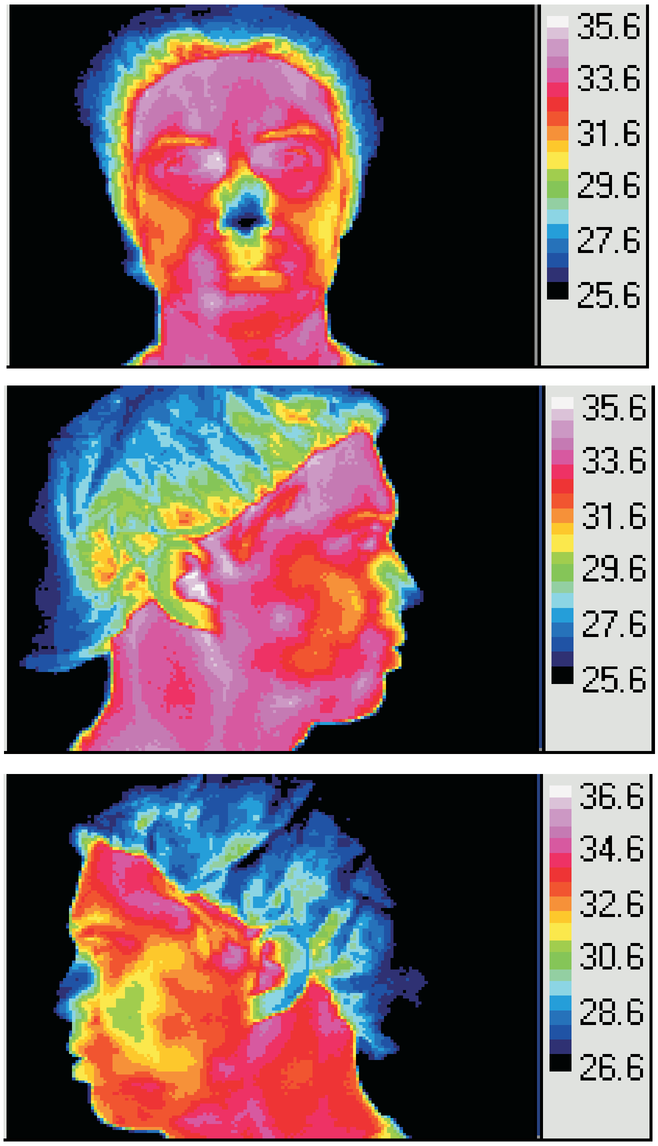

Figure 3
Front view and lateral views of the face 1 hour after the second injection of sumatriptan

first injection. In figure 1E the nose is 6°C cooler compared to the forehead.

The images of figure 3 were taken 1 hour after the second injection. The nose is 8 °C cooler than forehead. The lateral views done one hour after 2nd injection show prominent asymmetry. One hour after the second injection when the patient was not pain free there was less improvement in the arterio-venous shunting in the affected right side. The thermal image from the front view is indicating vasomotor abnormality persisted compared to the left side of the face. The left lateral face view shows cooling compared to baseline due to closing of the shunts in the microvasculature.

Discussion

Migraine patients have both intra and extra cranial vasomotor abnormalities. Thermography can image extracranial vasomotion by imaging dynamic changes of temperatures caused by variation in extracranial/ facial bloodflow. The arterio-venous shunting in the external carotid territory seems to correlate with clinical response in this case.

Dalla Volta [21] has studied the normalization of thermal symmetries following drug treatment, relationship of facial thermal patterns with central sensitization and the effect of migraine treatment on the neurovascular modifications due to pain relief.

In this case study the emphasis was on the effect of Imitrex® (Sumatriptan Succinate Injection) on the facial temperature. The time interval for recording of thermal images was related to the half life of CGRP (Calcitonin Gene Related Peptide), which is released into jugular venous blood during migraine attack (15). CGRP is one of the most potent endogenous vasodilators known. The release of CRGP is blocked by sumatriptan, which has also a direct vasoconstrictive property. In addition, the HT receptor agonist inhibits also activation of the trigeminal nerve and can influence the vicious migrainous circle by interuption of axon reflexes and decrease of neurogenic inflammation [22] All these actions result in more vasoconstriction than vasodilation leading to pain relief in acute migraine attacks.

Conclusion

The findings in this case supports the ability of thermal imaging to visualize the dynamic nature of the arterio-venous shunting at the microvascular level in response to treatment. The areas involved in the shunting and the temperature changes correlated with the angiosomes of the head. The changes in the Forehead-Nose thermal ratio following the first injection was correlated with pain relief in this patient.

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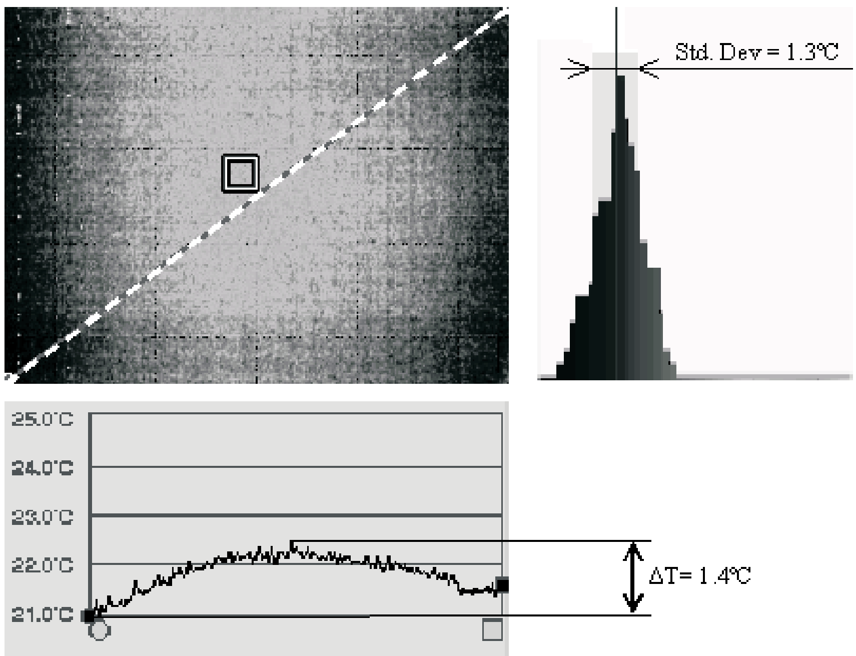
Correction

In the article by P.Plassman, E.F.J. Ring and C.D. Jones entitled Quality Assurance of Thermal Imaging Systems in Medicine. Thermology international 2006, 16: 10-15 a layout error occurred.

On page 13, table 4 repeated the text that was originally assigned to table 5. The correct text of table 4 is shown below.

We regret this error.

Table 4: Image non-uniformity	
Problem Severity	Usually small, although it can become severe in faulty cameras or those not calibrated for a long time.
Consequences	As in the "offset variation over measurement range" experiment in Table 3 above, this effect influences the accuracy of intra-image temperature difference measurements..
Cause	In focal plane array cameras non-uniformity is caused by inevitable drift of individual pixels away from the characteristics programmed into the calibration table of the camera (one for each pixel). In scanning cameras shortcomings of the optical elements (mainly lenses) cause this effect.
Materials required / preparation	Container of water at room temperature. Switch the camera on and allow it to settle (about 1 to 2 hours, use the results of the start-up drift experiment in Table 1). Set the camera to an emissivity of 0.98 (for 3-5μm cameras) or 0.99 (for 9-12μm cameras) respectively, a distance of 1 m and a very narrow temperature around the temperature of the water, e.g. if the water is 25 °C, set the camera range to between 23 and 27 °C.
Experimental method	After the camera has settled, stir the water for 30 seconds to produce a homogeneous temperature distribution at the surface. Point the camera perpendicular towards the water surface from a distance of 1 meter and record an image.
Analysis	Errors caused by deficiencies of the lens system are strongest in the corners of the image A cross-section temperature profile from corner to corner of the captured images exposes these as shown in figure 4. The figure also shows a statistics area and its respective histograms where the standard deviation is another measure for the camera's non-uniformity (noise). Diagonal and mid field lines through the image may all be examined in the same way.
Example	 Figure 4: Non-linearity between opposite corners of a thermal image (dashed line) and pixel noise in a representative area (square). The cross-section is shown below the image, the noise level is represented in the histogram to its right.

InfraMedic entwickelt automatischen Befundgenerator für MammoVision

Einfache Erstellung aussagekräftiger Arztberichte auf Knopfdruck

Ein weiterer Meilenstein für die Infrarot-Mammographie wurde jetzt an InfraMedic-Partner, die sich mit präventiven Brustuntersuchungen nach dem System MammoVision beschäftigen, ausgeliefert: ein automatischer Befundgenerator, der auf einen Knopfdruck hin sofort einen aussagekräftigen Arztbericht mit allen wesentlichen Ergebnissen der Untersuchung unter Einbezug der wichtigsten Infrarotbilder erstellt.

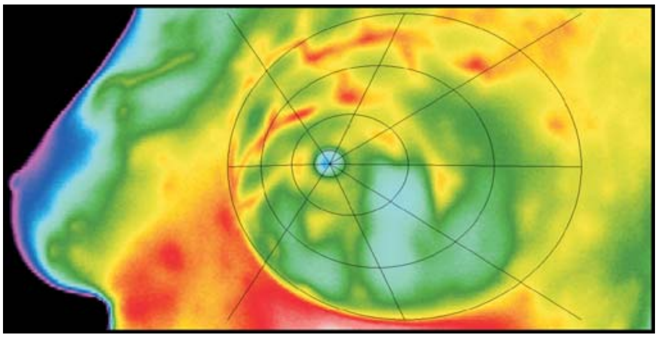


Bild 1:Netzprojektion

Basis des Berichts ist das mehrfach patentierte Netzprojektions- Koordinatensystem (vgl. Bild 1), welches auf größtmögliche Benutzer- freundlichkeit hin entwickelt und in langjähriger Forschung evaluiert wurde. Intelligente Hilfsmittel gewährleisten, dass die Position der Netze sowohl vor und nach der Abkühlung als auch nach längerer Zeit bei Wiederholungsuntersuchungen praktisch identisch ist - eine wesentliche Voraussetzung für exakte und zuverlässige Auswertungen.

Nach der Positionierung der Netze beginnt der zweistufige automatisierte Diagnoseprozess. Im ersten Schritt errechnet der Computer aufgrund evaluierter ärztlicher Vorgaben, inwieweit sich statistische Kenngrößen wie Temperaturunterschiede zwischen links und rechts, Homogenität der Infrarot-Abstrahlung etc. von der erwarteten Normalverteilung unterscheiden. Zunächst werden diese Abweichungen auf einer farbcodierten Grafik veranschau. licht (vgl. Bild 4), zusätzlich wird vom Computer aufgrund der Berechnung des Grades der Abweichungen und damit der klinischen Auffälligkeit eine Kennzahl vergeben (vgl. Bild 2).

In einem weiteren Schritt erfolgt die visuelle ärztliche Beurteilung (vgl. Bild 5). Anhand von fünf Kriterien, für die es jeweils vorgegebene Auswahlmöglichkeiten gibt, kann der qualifizierte Arzt in kürzester Zeit eine abschließende Bewertung vornehmen. Diese wiederum rechnet der Computer in eine weitere Kennzahl um und addiert sie zu der maschinell errechneten Kennzahl von Schritt eins.

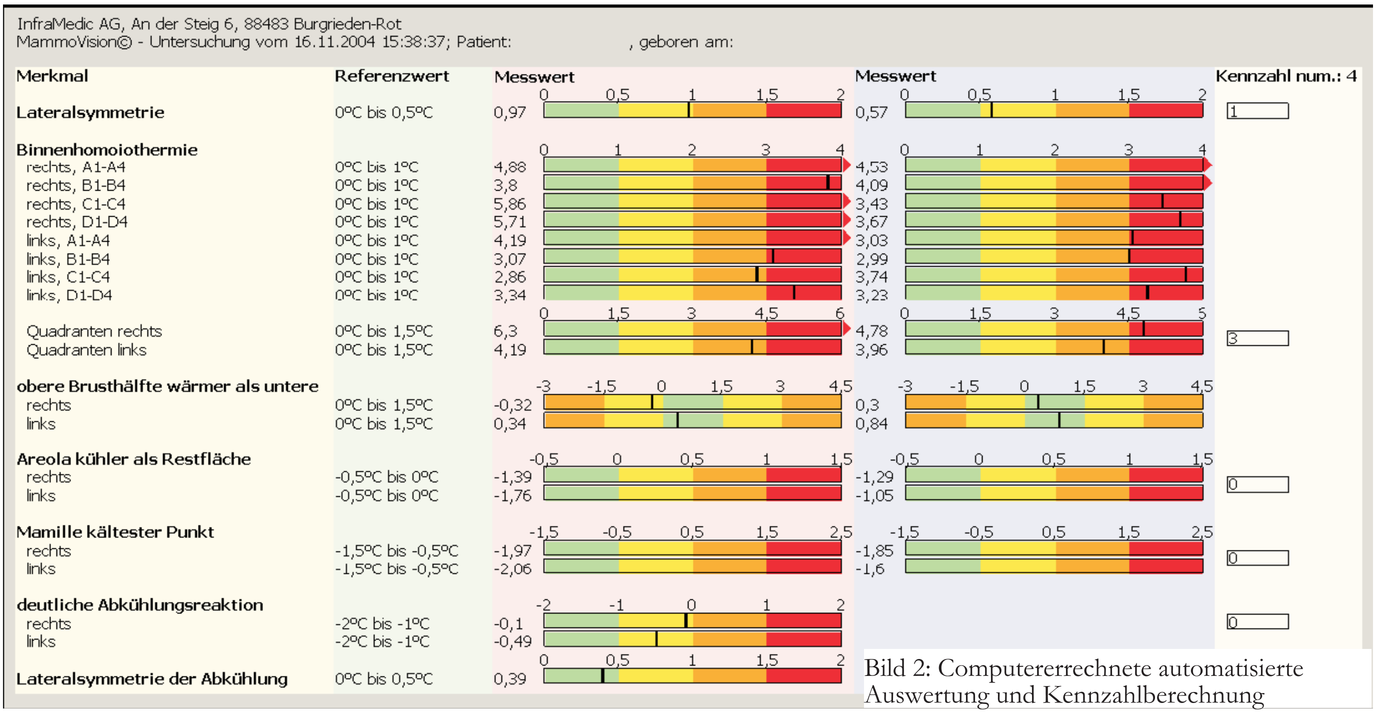


Bild 2: Computererrechnete automatisierte Auswertung und Kennzahlberechnung

Zeitersparnis

Bisher war es anschließend Aufgabe des Arztes, einen umfangreichen Bericht über die Untersuchungsergebnisse abzufassen, zu diktieren, von der Helferin schreiben zu lassen, ihn wieder zu korrigieren und dann die Endfassung auf dem Praxisbriefbogen erstellen zu lassen - erfahrungsgemäß ein zeitaufwändiger Prozess für Arzt und Helferin.

Aufgrund eigener ärztlicher Praxiserfahrung kennt man bei InfraMedic das Problem der immer knapperen zeit- lichen und personellen Ressourcen im ärztlichen Alltag. Deshalb entschloss man sich zu einer weit reichenden innovativen Entwicklung: der automatisierten Erstellung aussagekräftiger Befundberichte, in denen alle wichtigen Resultate der Untersuchung enthalten sind. In die Mammo-Visions-Software wurde ein automatischer Befund.generator eingebaut, der auf einen einzigen Knopfdruck einen Befundbericht einschließlich informativer Infrarot-Abbildungen und allen Praxisdaten des Arztes erstellt.

Selbstverstandlich kann der Arzt den Bericht noch abändern und weitere Bemerkungen (beispielsweise Empfehlungen für Zu- satzuntersuchungen oder für therapeutische Interventionen) hinzufügen. Oft kann der Bericht jedoch komplett und unverändert übernommen werden. Zu. gleich sind alle Praxisdaten des Arztes einge. fügt.

Neben der erheblichen Zeitersparnis ist damit sichergestellt, dass die Mammo-Visions-Befundberichte immer in gleicher Weise strukturiert aufgebaut sind und keine Details ver- gessen werden. Zudem dokumentiert der beurteilende Arzt gegenüber Patienten wie auch Kollegen sein hohes professionelles Ni veau.

Gleichzeitig können solche qualifizierten Arzt- berichte mit entsprechender Illustration durch Infrarotbilder ein wirksames Marketing-Instrument für die Mammo- Visions-Methode und auch die eigene Praxis sein. Oft werden sie im Bekanntenkreis der Patienten gezeigt, und auch bei ärztlichen Kollegen wird das Interesse an dieser Untersuchung wahrscheinlich wachsen und weitere Überweisungen auslösen.

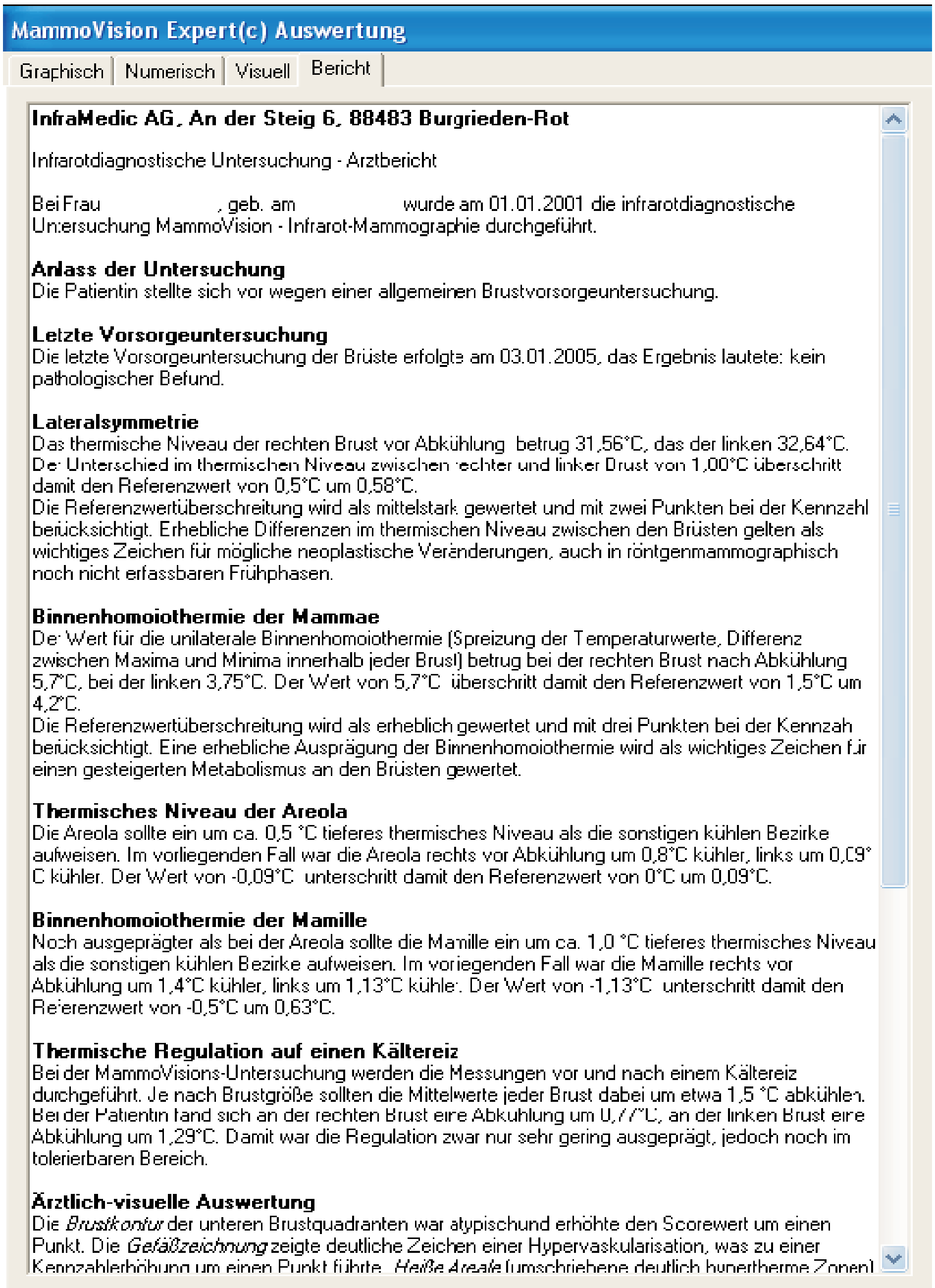
Auch Gutes lässt sich verbessern

Wie bei InfraMedic üblich werden alle Anregungen der Anwender, wie sie sich erfahrungsgemäß durch den Einsatz des automatischen Befundgenerators in der Praxis einstellen, zeitnah in Programmaktualisierungen eingebaut und in der Regel in den ersten zwei Jahren nach Anschaffung des Systems kostenfrei nachgeliefert. Damit wird sichergestellt, dass alle Anwender der MammoVisions-Methode immer auf dem gleichen Stand von Forschung und Entwicklung bleiben und an allen innovativen Fortschritten teilhaben.

Ausblick

Weiterhin ist geplant, auch fur andere Infrarot- Diagnosebereiche innovative Befundungs- und Auswertegeneratoren zu entwickeln. Denkbar sind diese sowohl in der Humanmedizin (Gefäßdiagnostik, Ganzkörper-Untersuchungen, Rücken- und Gelenksdiagnostik etc.) als auch bei den veterinärmedizinischen Infrarot-Untersuchungen (Lahmheitsdiagnostik, Huf- und Sattelbeurteilungen bei Pferden etc.). Der Anspruch von InfraMedic auf die führende Rolle als Entwickler und Hersteller von Infrarot-Diagnosesystemen in der Human- wie auch Veterinärmedizin in Europa wird damit erneut verdeutlicht.

Bild 3: Arztbericht



MammoVision Expert(c) Auswertung

Graphisch | Numerisch | Visuell | Bericht

InfraMedic AG, An der Steig 6, 88483 Burgrieden-Rot

Infrarotdiagnostische Untersuchung - Arztbericht

Bei Frau , geb. am wurde am 01.01.2001 die infrarotdiagnostische Untersuchung MammoVision - Infrarot-Mammographie durchgeführt.

Anlass der Untersuchung
Die Patientin stellte sich vor wegen einer allgemeinen Brustvorsorgeuntersuchung.

Letzte Vorsorgeuntersuchung
Die letzte Vorsorgeuntersuchung der Brüste erfolgte am 03.01.2005, das Ergebnis lautete: kein pathologischer Befund.

Lateralsymmetrie
Das thermische Niveau der rechten Brust vor Abkühlung betrug 31,56°C, das der linken 32,64°C. Der Unterschied im thermischen Niveau zwischen rechter und linker Brust von 1,00°C überschritt damit den Referenzwert von 0,5°C um 0,58°C.
Die Referenzwertüberschreitung wird als mittelstark gewertet und mit zwei Punkten bei der Kennzahl berücksichtigt. Erhebliche Differenzen im thermischen Niveau zwischen den Brüsten gelten als wichtiges Zeichen für mögliche neoplastische Veränderungen, auch in röntgenmammographisch noch nicht erfassbaren Frühphasen.

Binnenhomoiothermie der Mammae
Der Wert für die unilaterale Binnenhomoiothermie (Spreizung der Temperaturwerte, Differenz zwischen Maxima und Minima innerhalb jeder Brust) betrug bei der rechten Brust nach Abkühlung 5,7°C, bei der linken 3,75°C. Der Wert von 5,7°C überschritt damit den Referenzwert von 1,5°C um 4,2°C.
Die Referenzwertüberschreitung wird als erheblich gewertet und mit drei Punkten bei der Kennzahl berücksichtigt. Eine erhebliche Ausprägung der Binnenhomoiothermie wird als wichtiges Zeichen für einen gesteigerten Metabolismus an den Brüsten gewertet.

Thermisches Niveau der Areola
Die Areola sollte ein um ca. 0,5 °C tieferes thermisches Niveau als die sonstigen kühlen Bezirke aufweisen. Im vorliegenden Fall war die Areola rechts vor Abkühlung um 0,8°C kühler, links um 0,09°C kühler. Der Wert von -0,09°C unterschritt damit den Referenzwert von 0°C um 0,09°C.

Binnenhomoiothermie der Mamille
Noch ausgeprägter als bei der Areola sollte die Mamille ein um ca. 1,0 °C tieferes thermisches Niveau als die sonstigen kühlen Bezirke aufweisen. Im vorliegenden Fall war die Mamille rechts vor Abkühlung um 1,4°C kühler, links um 1,13°C kühler. Der Wert von -1,13°C unterschritt damit den Referenzwert von -0,5°C um 0,63°C.

Thermische Regulation auf einen Kältereiz
Bei der MammoVisions-Untersuchung werden die Messungen vor und nach einem Kältereiz durchgeführt. Je nach Brustgröße sollten die Mittelwerte jeder Brust dabei um etwa 1,5 °C abkühlen. Bei der Patientin fand sich an der rechten Brust eine Abkühlung um 0,77°C, an der linken Brust eine Abkühlung um 1,29°C. Damit war die Regulation zwar nur sehr gering ausgeprägt, jedoch noch im tolerierbaren Bereich.

Ärztlich-visuelle Auswertung
Die *Brustkontur* der unteren Brustquadranten war atypischund erhöhte den Scorewert um einen Punkt. Die *Gefäßzeichnung* zeigte deutliche Zeichen einer Hypervaskularisation, was zu einer Kennzahlerhöhung um einen Punkt führte. *Heiße Areale* (umschriebene deutlich hypertherme Zonen)

Die Infrarot-Anwendung EXAM in der Version 4 - Für Humanmedizin, Infrarot-Mammographie, Veterinärmedizin, Gebäudethermographie

Mehr Kunden und Anwender in unterschiedlichen Bereichen bedeuten auch ein Mehr an Wünschen und Anregungen für die ständig in der Weiterentwicklung befindliche Infrarot-Software EXAM von InfraMedic, welche in der Version 4.5 auf einem sehr hohen Stand an Perfektion, Innovation und Professionalitat ist.

Die Anwendung EXAM steht im Mittelpunkt unserer Infrarot-Systeme. Mit ihr werden Aufnahmen vorgenommen, Untersuchungen beurteilt und ausgewertet und Daten verwaltet.

Die Software ist fur Anwender ausgelegt, die den Computer ausschließlich als Arbeitsmittel einsetzen und auser von der Bedienung der meistgebrauchten Programme keinerlei Kenntnisse über Computer, Betriebs- und Dateisystem besitzen. Die immense Funktionsvielfalt wird dem Anwender mittels einer ausgeklügelten Benutzungsoberfläche stets übersichtlich und intuitiv auf seinen Anwendungsbereich zugeschnitten bereitgestellt.

Nachfolgend die wichtigsten Funktionen im Überblick, in die Hauptbereiche unterteilt:

Bereich Aufnahme bei stationaren Systemen (HiRes Clinic und Ultra-Res)

- Ein Assistent führt den Anwender durch Dialoge zur Auswahl der Untersuchungsdaten wie Patientendaten, Umgebungstemperatur und Messart
- Auch die Messung verläuft sehr geradlinig, durch visuelle Hinweise und Sprachausgabe unterstützt. Die sechs Kameraeinstellungen und die Abkühlungsphase der Standardmessung MammoVision werden linear durchlaufen, wobei der Anwender stets die Möglichkeit hat, Einzelbilder aufzunehmen.
- Durch eine beliebig erweiterbare Liste von vordefinierten Bildernamen konnen Einzelbilder schnell und konsistent direkt bei der Aufnahme benannt werden, ohne die Notwendigkeit zur Eingabe über die Tastatur
- Bei der ersten Untersuchung eines Patienten legt der Anwender die Position der Brüste auf dem Bildschirm (mittels eines Klicks auf die Brustwarze) und deren Entfernung zur Kamera fest. Diese Informationen ermöglichen es, die Brüste bei Folgeuntersuchungen immer gleich auszurichten, eine essenzielle Voraussetzung für die computergestutzte Auswertung.

Bereich Aufnahme bei portablen Systemen

- Die Aufnahme wird mit der Kamera durchgeführt
- Ein Assistent führt den Anwender durch den Überspielvorgang der Messdaten auf den PC und deren Zu-Bereich Beurteilung (vgl. Bild 3)
- Leichte Auswahl und Darstellung einer Untersuchung durch Angabe eines Patienten und eines zugehörigen Untersuchungsdatums mittels zweier Mausklicks

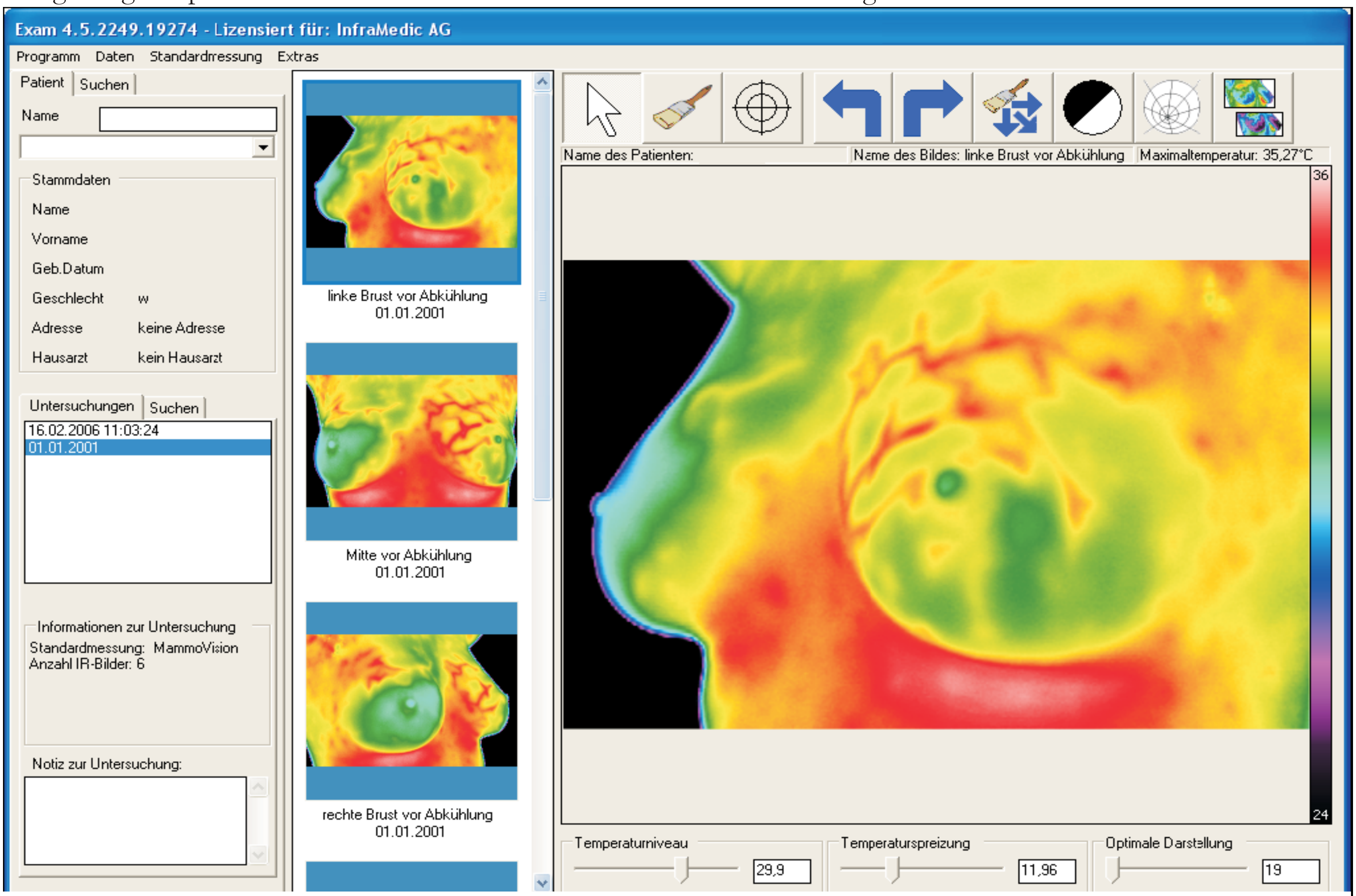


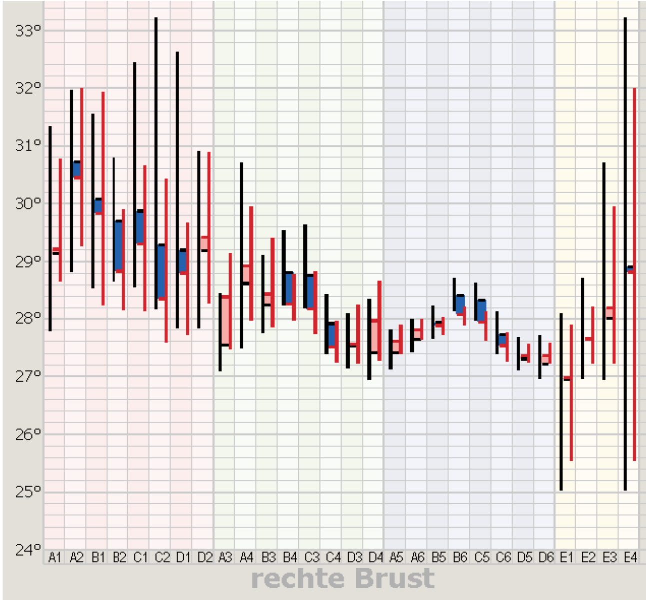
Bild 3 Hauptformular von EXAM

- Suche nach Infrarot-Bildern in allen bzw. im ausgewählten Patienten mittels Eingabe eines Teils des Namens des gesuchten Infrarot-Bildes über die Tastatur oder per Auswahl eines Namens aus der Liste vordefinierter Bildernamen
- Einfache Anpassung der Darstellung der Temperaturinformationen über Schieberegler und Übertragungsmoöglichkeit dieser Darstellungs-Einstellungen auf andere Infrarot-Bilder
- Erstellung von Vergleichsansichten, in welchen Infrarot-Bilder aus verschiedenen Untersuchungen - auch von unterschiedlichen Patienten - nebeneinander dargestellt werden konnen, eine wichtige Funktionalität für die Therapiekontrolle.

Bereich Auswertung: Patentiertes Experten-Auswertungsmodul für MammoVision

- Computergestützte Erstellung von Netzen, welche die Brustkonturen nachbilden und die Brüste in Areale unterteilen
- Grafische Darstellung der Temperaturverteilung (vgl. Bild 4): Die Temperaturverteilung innerhalb der Areale wird durch eine grafische Zusammenstellung von Minima, Maxima und Durchschnittstemperaturen angezeigt. Dies gewährt dem geübten Anwender eine rasche Übersicht, da hier normale sowie abweichende Temperaturverteilungen charakteristische Muster ergeben.
- Numerische Auswertung (vgl. Bild 2): Mittels der Netze werden vom Computer mehrere Kriterien wie Binnenhomoiothermie und Lateralsymmetrie berechnet und grafisch aufbereitet. Im Vergleich mit Referenzwerten werden die Gewichtigkeiten eventueller Abweichungen mit Punkten bewertet und daraus die "numerische Kennzahl" generiert.
- Visuelle Auswertung (vgl. Bild 5): mehrere Kriterien wie die Brustkontur der unteren Quadranten und Gefäßzeichnung stehen zur Bewertung durch den Anwender bereit. Ähnlich der numerischen Auswertung werden die Gewichtigkeiten eventueller Abweichungen mit Punkten bewertet und daraus die "visuelle Kennzahl" erstellt. Aus der Addition der beiden genannten Kennzahlen ergibt sich die "Gesamtkennzahl", welche eine Aussage uber den Zustand der Brüste gibt.

Bild 5 Grafische Darstellung der Temperaturverteilung



- Automatischer Befundbericht- und Arztbriefgenerator: auf Basis der Ergebnisse der numerischen und visuellen Auswertung sowie der Daten rund um Patient und Untersuchung erstellt der Generator aus Textbausteinen einen Bericht, der dem Arzt den überwiegenden Teil der Befundungsdokumentation abnimmt.

Bereich Verwaltung

- Verwaltung des gesamten Datenaufkommens, z.B. Anlegen und Entfernen von Patienten und Untersuchungen und Ändern von Stammdaten
- Export / Import von Infrarot-Bildern und ganzen Untersuchungen, unter anderem wesentliche Voraussetzung für eine Auswertung per Fernübertragung.

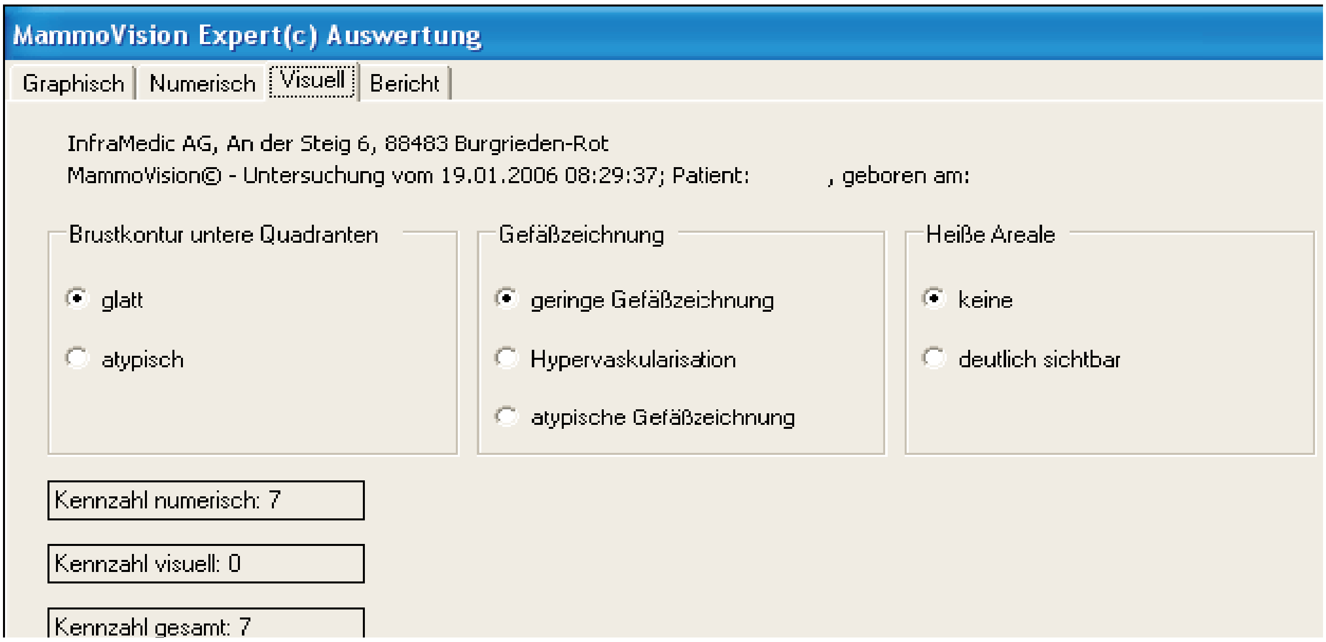


Bild 5 Visuelle Auswertung

Use of thermal imaging in complementary medicine

Kurt Ammer

Austrian Society of Thermology, Vienna, Austria

Review of the paper by Popp FA, Klimek W, Maric-Öhler W, Schlebusch KP. **Visualisierung vom meridianähnlichen Ausbreitungspfaden nach optischer Reizung im infraroten Spectralbereich.** Dtsch Z Akupunkt 2006, 49(1): 6-18

The group Schlebusch, Maric-Öhler and Popp made another (already the third) attempt (1,2,3) to prove the existance of acupuncture-meridians using thermal imaging for visualization. In this study the authors used repeatedly a moxa cigar in a distance of one to several decimeters from the body surface for indirect moxibustion. After this procedure, they detected linear bands of elevated infrared emittance close to the localisation of acupuncture meridians. By comparison the temperature of these "meridian-like-channels" measured with contact thermometers and with infrared, the authors reject the argument that their findings may be just reflections on the skin. However, the attempt to repeat this study and confirm the findings in a randomized controlled study failed (4).

The studies of Schlebusch et al have several flaws both in methodology and in interpretation of findings. It is out of question that infrared thermography is a measure of infrared radiation which is part of electromagnetic spectrum. Nevertheless the infrared radiance detected by the infrared imager is displayed in temperature values (5). Therefore, differences in temperature obtained by contact or remote measurement are strong arguments for an additional infrared source. A strong heat source (probably the moxa cigar) is visible in five of nine images of the most recent publication (1). The heat radiating to the investigated body below the heat source is also very obvious.

The human skin is reflecting infrared of wavelengths below 6µm (6) which is different to the authors statement on wavelength dependent reflection. According to Kirchhoffs Law adsorption and emission of energy is equal and if the sum of absorbed and reflected energy is equal to 1, skin emissivity should be on the same high level thougout the whole range of the infrared spectrum, if reflection does not occur. But already Hardy had shown that uniform emissivity with a value close to 1 starts from wavelengths of 8µm on (7), although another peak of emissivity with values between 0.8 to 0.9 exists at the wavelength band between 4.5 and 5.5 µm.Skin emissivity is in the range between 0.5 and 0.8 at wavelengths 3,5 to 4.5 µm, and 0.7 to 0.9 at wavelengths 5.5 to 8µm. Therefore, reflection of infrared waves will occur in the wavelength bands of 3-4.5 which is within the sensitivity of the infrared camera used for stimulated meridian detection.

P. Plassmann showed recently another equipment dependent measurement error, which was named "Thermal Flooding Effect"(8). Flooding is caused by the introduction of a warm object into the observed scene. Radiation from the warm object "floods" the entire image area, making other objects appear to be warmer than they are. The underlying cause for this effect is insufficiency in the optical path of the camera, e.g. stray radiation. The error is small in cameras with good lens systems, moderate in others. It affects inter-image measurements, for example in timed series and also absolute temperature readouts in individual images.

Finally, the authors used the infrared camera as an imager and not as a measuring divice for recording infrared radiation.That means, images were not taken in standard positions of the patient and variations in temperature measurements due to missing radiation caused by an increased angle of view from the camera to the object could occur. Temperature measurements were mentioned, but neither the method obtaining this measurements is reported nor measurement areas or spot measurements can be seen on the thermal images. In addition, the colour scale is in a different range in each thermal image, which maked the comparison by the eye completely impossible.

This kind of publication (1) neither help acupuncture to achieve a status of a reliable medical treatment nor to understand the mechanism of action of traditional chinese medicine. For thermal imaging, it may be used as argument that this technique is not based on science, has no evidence for utility in medicine and is just used by quacks.

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News in Thermology

MIRA Seminar in Bad Beversen

MIRA (Medical InfraRed Academy) and the German Society of Thermography and Regulation-Medicine organised another Infrared Seminar in cooperation with Cardiovascular Centre Bad Beversen, on April 12, 2006. This event provided instruction and training for users of infrared imaging in the fields of human and verterinary medicine. The Physicans Chamber of Niedersachsen credited this course with 10 points for continuous medical education.

Ass.Prof Dr C Kugler, head of the department for angiology in Bad Beversen was one of the lecturers of this meeting. He started last year an scientific investigation focusing the utility of infrared imaging in vascular disorders in comparison with plethysmography and oszillometry. Preliminary results indicate that infrared thermography can obtain similar informations as the established techniques mentioned above.

Discussion on breast thermography in US

The American Academy of Thermology had to face a partly public discussion on breast thermography driven by people who provide services of complementary medicine. These people claim that thermography can objectively differentiate between healthy and diseased tissue of the female breast. In addition, preventive modalities of unproven utility should be monitored by thermal imaging.

This proposal is in complete contrast to existing guidelines (1) and recommendations (2, 3). The guideline of the American Cancer Society (1) says that clinical evidence indicates that thermal imaging is ineffective as a screening tool. However, the technique received.FDA approval for general clinical use. A recent health technology assessment document (4) from New Zealand came to the conclusion that the evidence that is currently available does not provide enough support for the role of infrared thermography for either population screening or adjuvant diagnostic testing of breast cancer. The major gaps in knowledge at this time can only be addressed by large-scale, prospective randomised trials. More robust research on the effectiveness and costs of technologically advanced infrared thermography devices for population screening and diagnostic testing of breast cancer is needed.

Nevertheless, chiropractors (5), homeopaths (6) and acupuncturists promote (7) the use of thermal imaging as a alternative screening test instead of mammography. These activities might end for thermography in a similar disaster as experienced in the past, when hundreds of physicians in France and Germany ceased to use of this technique in the late nineteen-eighties, because the diagnostic promises of thermography could not be fullfilled and both the health system and the insurance companies had stopped to pay reimbursement for thermographic breast testing . As a consequence, the thermographic societies in France and Germany lost many members with the result that the French society ceased the existance and the German Society of Thermology shrinked in size to 20% of original member numbers.

A recent report from the Cleveland Clinic in ABCs "Good Morning America (8) where Dr David Weng examines patients with chemotherapy for breast cancer in weekly intervals with thermography, shows ar least that there is a place for thermal imaging in evidence based medicine, but does not yet give evidence for the utility of thermal imaging for monitoring the course and treatment of malignamt breast disease. At least, breast thermology has received a large national forum,

Peter Plassmann from the University of Glamorgan, UK, proposed to counteract the development "where crooks dominating the field" by going public. He suggested a publication such as "IR Imaging for the Screening of Breast Cancer: A State-of-the-Art Joint Position Paper". This paper should be short, written in very simple and unambiguous terms and clearly define what is proven fact, what is hypothetical and what belongs to the domain of quack. It should be jointly written and endorsed as a position paper by all relevant 'IR in Medicine' societies and groups. It should then be circulated widely to the relevant government departments, health authorities, charities, web sites, etc.

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8 Johnson T "Good Morning America." from April 13, 2006 ABC News Internet Ventures

Audit of the Italian Health Ministry on indications for thermal imaging in medicine

Dr. Giorgio Dalla Volta, neurologist in Brescia and president of the Italian Association of Thermology, had to meet a high challenge in the end of March, when he had to defend the utility of thermal imaging in medicine in an audit raised by CUD, a commission of the Italian Ministry of Health. The unfavourable starting point for thermography was a report from 2004, which did not support the clinical evidence for using thermography based on a literature search in medline spanning the last 10 years. This report found only 16 papers related to the clinical evidence of diagnostic value of infrared imaging. The methodological quality of these papers was classified as poor because of small populations and the lack of controls.

This document, which seems to be the basic for the intended audit, refers also to the policy manual of the Regency Insurance Group in the US. This assessment came to the conclusion that there is insufficient evidence in the peer-reviewed published literature to reach conclusions concerning the effects of thermography on health outcomes for any indication. The scientific literature is inadequate to validate the clinical role of thermography; no published studies demonstrate how the results of thermography can be used to enhance patient management and improve patient health outcomes. However, this paper is the combined assessment of contact thermography and advanced digital infrared thermal imaging. In addition, it misses some of the more recent papers as most of the printed quotation were published between 1964 and 1990. The technique was at least classified as a technique for research.

An other argument against thermal imaging in this report of the Italian Health Ministry is the fact, that recommendations for thermography as diagnostic procedure are missing in many guidelines edited by medical societies. However, these statement is based on a not comprehensive literature search.

This journal publishes an annual literature review on thermography and temperature measurement since 1991. Cumulating the number of papers dedicated to the diagnostic value (i.e. sensitivity and specificity) of temperature measurements from 2001 onwards, found in total 91 papers. Therefore, it seems to be a sign of poor search strategy that all the papers mentioned above could not find more than 25 papers to find evidence in favour or against the diagnostic value of thermal imaging. Also the recent chapter on infrared imaging in volume 3 "Medical Devices and Systems" of the Biomedical Engineering Handbook, Third Edition (3) supports ongoing research and standards achieved in thermal imaging.

The outcome Dr. Dalla Volta´s endeavour to defend the diagnostic value of infrared imaging against the miss-classification by public and govermental institutions is not yet known But, information about this matter will be continued..

References

1. http://www.ministerosalute.it/imgs/ C_17_pagine Aree_ 88_ listaFile_ itemName_0_file.pdf

2. http://www.regence.com/trgmedpol/radiology/rad17.html

3. Bronzino JD (Ed) Medical Devices and Systems, Biomedical Engineering Handbook (3rd. Edition). CRC Press 2006

Meetings

28-30 June 2006

QUIRT 2006,The 8th Quantitative Infrared Thermography International Conference, Padova, Italy

ADVANCE TECHNICAL PROGRAMM

Invited lectures

Thermography and microsystems-Some ways to intensify quantitative experimentation in heat transfer, Jean-Christophe. Batsale

Visible and Infrared Imagery for Surveillance Applications: Software and Hardware Considerations, Xavier Maldague et al.

An overview on hypersonic flow research with infrared thermography, Gennaro Cardone

Solids Mechanics and Thermoelastic Effects

Thermomechanical study of TiNi shape memory alloy during low cycling test, Elzbieta Pieczyska, Stefan Gadaj, Wojciech Nowacki and Hisaaki Tobushi

Assessment of fatigue damage in a mild steel using Lockin-Thermography, Justus Medgenberg and Thomas Ummenhofer

Evaluation of storage energy of the constructional steel during plastic deformation, A.M. Ivanov, E.S. Lukin and B.G. Vainer

Self-heating effects on strain measurements performes by embedded fibre optic sensors under cyclic loading, Leonardo D'Acquisto and Roberto Montanini

Thermography as a routine diagnostic for mechanical testing of composites, P. Levesque, P. Brunet, C. Cluzel, A. Déom, L. Blanchard and D.L. Balageas

Energy dissipation in medium and high cycle fatigue of metallic and composite materials, G. Meneghetti and M. Quaresimin

Combined thermoelastic and thermographic data for the evaluation of crack growth in industrial components, U. Galietti and D. Modugno

QIRT associated to Digital Image Correlation to perform thermomechanical analysis of the yeld behaviour of a semicristalline polymer, J.M. Muracciole, B. Wattrisse, Y. El Kaim, A. Chrysochoos

Analysis of Thermal Stress in Fatigue Fracture Specimen using Lockin Thermography, Won-Tae Kim, Man-Yong Choi, Jung-Hak Park

Energetics

Thermal transient mapping systems for integrated semiconductor devices and circuits, Lucio Rossi, Giovanni Breglio, Andrea Irace and Paolo Spirito

Thermographic inspections on mini evaporators to evaluate periodic boiling heat transfer coefficients, S. Filippeschi and G. Salvadori

Combined CFD and infrared thermal analysis of a wood refuse and dimethyl-ether co-fired flame, Tudor Prisecaru, Lucian Mihaescu, Constantin Dumitrascu, Malina Prisecaru, Nicolae Panoiu, Elena Popa and Ion Oprea

Research and testing of fuel oil combustion, using flame infrared thermography, Victor V. Ghiea

Image Processing and Data reduction

The Application Of Principal Component Analysis Using Fixed Eigenvectors To The Infrared Thermographic Inspection Of The Space Shuttle Thermal Protection System, K. Elliott Cramer and William P.Winfree

Defect quantification with thermographic signal reconstruction and artificial neural networks, Hernan Benitez, Clemente Ibarra-Castanedo, Humberto Loaiza, Eduardo Caicedo, Abdelhakim Bendada and Xavier Maldague

A neural approach for thermographic image analysis, Tiziana D'Orazio,Marco Leo, Arcangelo Distante, Vittoria Pianese, Gennaro Borzacchiello and Giovanni Cavaccini

Enhanced reconstruction of thermographic signals for NDT, Steven Shepard, Yulin Hou,James Lhota and Tasdiq Ahmed

Thermography applied to the evaluation of non-uniform deformation heat of metals, J.Wullink, F.D. van den Berg and P.van Liempt

Phase contrast using differentiated absolute contrast method, Mirela Susa, Hernan Benitez, Clemente Ibarra-Castanedo, Humberto Loaiza and Xavier Maldague

A method to integrate thermographic data and 3D shapes for Diabetic Foot Disease, S. Colantonio, G. Pieri, O. Salvetti, M. Benvenuti, S. Barone and L.Carassale

Quantitative 3d-Thermography, Wilhelm Satzger, Günter Zenzinger and Volker Carl

Fluid Mechanics

Thermal characterization and kinetics analysis of reaction microfluidic medium by Infra-Red Thermography, Christophe Pradère, Mathieu Joanicot, Jean-Christophe Batsale, Jean Toutain and Christophe Gourdon

Experimental study of the Heat Transfer Coefficient distribution in a single finned tube model: effect of fin spacing and flow velocity, M.Sanhaji, D. Bougeard, A. El abbadi, M. Nacer bey, S. Russeil and B. Baudoin

Infrared thermography for shear stress field measurements in flows,Gianluca Rossi, Jacopo Pirisinu

Utilization of the infrared thermography to identify the convective heat transfer coefficient into a rotating cylinder with an axial airflow, S.Seghir-Ouali, D. Saury, S. Harmand, O. Phillipart and D. Laloy

Heat Transfer Measurements in Rotating Channel, Mauro Gallo, Tommaso Astarita, Giovanni Maria Carlomagno

Determination of heat transfer intensity between free screaming water film and rigid surface using thermography, Srecko Svaic, I. Boras and Susa

Intensive cooling of large surfaces with arrays of jets, Carosena Meola and Giovanni Maria Carlomagno

Paints effect on the advanced quantitative infrared thermography applied to jet impacts, Reza Mehryar, André Giovannini and Sébastien Cazin

Thermographic analysis of acoustic disturbance effects on laminar separation bubble, Renato Ricci, Francesco Angeletti, Sergio Montelpare and Alessio Secchiaroli

Evaluation of the convective heat transfer coefficient in electronic cooling, Mourad Rebay, Rejeb Ben Maad, Sadik Kakac and Jacques Padet

Thermographic Systems and Components

Two channels NIR camera system to detect foreign matter in cotton, Stephan Böhmer, Helmut Budzier, Volker Krause, Gerald Gerlach and Thomas Pusch

Space resolution and accuracy in temperature of thermal focal plane array camera: evaluation of error in temperature from slit response function and calibration curve, Olivier Riou, Dominique Pajani and Jean Félix Durastanti

Near Infrared Thermography with Silicon Focal Plane Arrays -Comparison to Infrared Thermography, Yann Rotrou, Thierry Sentenac,Yannick Le Maoult, Pierre Magnan and Jean Farré

Calibration and performance evaluation of an uncooled Infrared Thermographic System, Sara Rainieri, Fabio Bozzoli and Giorgio Pagliarini

Thermal imaging for enhanced foreground-background segmentation, Louis St-Laurent, Donald Prévost and Xavier Maldague

Process Monitoring and industrial applications Simulation and evaluation of new thermographic techniques for the industrial deployment in the automotive industry, U. Siemer

Thermal analysis and thermographic measurements of piezoelectric transformers, K. Tomalczyk and B. Wiecek

Optimization of electronic devices placement on printed circuit board cooled by forced convection, M. Felczak and B. Wiecek

Application of Infrared thermography in investigation of transversal rolling of stainless steel, Tomasz S. Wisniewski, Jacek Pawlicki, Anna Druzycka-Wiencek , Franciszek Grosman and Krzysztof J. Kurzydlowski

Finding of the mechanical power distribution in an horizontal ring mill using infrared thermography, George Zannis, Maria Founti and Panagiotis Makris

Detection of rolling bearing degradation using infrared thermography, Atef Mazioud, Jean-Félix Durastanti, Laurent Ibos and Evelyne Surugue

Thermography in the investigations of the thermal deformations in NC machine tool bodies, Roman Staniek

On-Line Thermal Barrier Coating (TBC) Monitor for Real-Time Failure Protection and Life Maximization, Dennis H. LeMieux and Vinay Jonnalagadda

The Thermal Wave Method for Investigations of Textile Properties, M.Michalak, B. Wiecek, I. Kruci_ska and M. Felczak

Thermographycal Analysis of the coking oil-products degree , VladimirZaharenko

Radiometry and Metrology

Emissive Properties of Materials and its Relation with Roughness, Leszek Rozanski and Michal Wieczorowski

Can reflections strongly modify the measured surface temperature of plasma facing components in experimental fusion reactors like Tore- Supra, JET and ITER?, D. Guilhem

Calibration of incremental temperature fluctuations at high temperatures, Marija Strojnik and Gonzalo Paez

Measurement and calibration of temporal and spatial temperature differences of over 100 K, Gonzalo Paez and Marija Strojnik

New measurement methods for the thermal emissivity of semitransparent and opaque materials, Didier Demange, Michel Bejet and Bertrand Dufour

NDT and NDE

Defect detection in ceramic materials by quantitative infrared thermography, Gian Marco Revel and Simone Rocchi

Acoustic thermography using an un-cooled high speed camera and low power ultrasonic excitation: test system and its application to impact flaw detection in CFRP, Lothar Haupt, Uwe Hoffmann, Helmut Budzier, Norbert Meyendorf and Bernd Köhler

Comparative study between infrared thermography and laser vibrometry applied to flaws identification in composite materials, Daniel Pedro Willemann, Sinthya Gonçalves Tavares, Paolo Castellini, and Roberto Márcio deAndrade

Induction lock-in thermography and induction burst phase thermography for NDE applications, Gernot Riegert and Gerd Busse

Improved ultrasound activated Lockin-Thermography by frequency analysis of material defects, A. Gleiter, C. Spießberger, Th. Zweschper and G.Busse

Masurement of impact-damaged areas in commingled Eglass/polypropylene laminates via thermographic image analysis, Carlo Santulli

Pulsed Thermography in the assessment of composites for defectdetection and analysis, Nicolas P. Avdelidis, S Kenny

Reliability Testing on the Printed Circuit Board of Mobile Phone using Infrared Thermography, Hoon Joo, Won-Tae Kim, Man-Yong Choi

Civil engineering and works of art

Thermo-Hygrometrical Surveyings and Microclimate Monitoring at San Benedetto Po Abbey (Mantova-Italy), Davide Del Curto and AlbertoGrimoldi

Non-destructive testing of Building walls using active infrared thermography, Laurent Ibos, Mohamed Larbi Youcef, Atef Mazioud, Stefan Datcu and Yves Candau

Infra-red photothermal thermography: A tool of assistance for the restoration of murals paintings?, Jean Charles Candoré, Gabriela Szatanik, J.L Bodnar, Vincent Detalle and Philippe Grossel

Comparative study between infrared thermography and laser Doppler vibroetry applied to frescoes diagnostic, Sinthya Gonçalves Tavares, Alexia Agnani, Enrico Esposito, Mara Feligiotti and Roberto Marcio de Andrade

Thermal Patterns Due To Moisture Accumulation Within Exterior Walls, Antonio Colantonio and Garry Desroches Quantification of Voids and Delaminations in Real Concrete andMasonry Structures with Active Thermography: Case Studies, Ch.Maierhofer, R. Arndt, M. Röllig, R. Helmerich, A. Walther, B. Hillemeier, and C. Rieck

An infrared experimental approach to visualize thermal irregularities in historical building mansonry walls, F. Fantozzi, S. Filippeschi and F. Leccese

Passive and active thermography application for architectural monuments, M. Poksinska and B. Wiecek

Investigating heat engineering characteristics of building envelopes using infrared cameras, Oleg Lebedev, Vladimir Avramenko, Dmitry Kirzhanov and Oleg Budadin

Determination of critical moisture content in porous materials by IR thermography, A. Tavukcuoglu and E. Grinzato

Thermal NdE of FRP applied to civil structures, E.Grinzato, V.A.M. Luprano, S. Marinetti, P.G. Bison, A.Tundo and A. Tatì

Restoration mortars at IRT: optical and hygroscopic properties of surfaces, N. Ludwig, E. Rosina

Feasibility of different thermal analysis of FRP – reinforced concrete U. Galietti, P. Corvaglia, A. Largo, S. Nenna, L. Spagnolo

Bio-medical

Advances of Quantitative IR-Thermal Imaging in Medical Diagnostics, A. Z. Nowakowski

Thermographic analysis of phacoemulsification based cataract surgery procedures, Andrea Corvi, Bernardo Innocenti and Rita Mencucci

Advancements in biomedical applications of infrared imaging, Arcangelo Merla and Gian Luca Romani

Active dynamic thermography in cardiosurgery, Mariusz Kaczmarek, Antoni Nowakowski

Applicability of IR thermography to the measurement of stress in rabbit, Nicola Ludwig, Marco Gargano, Fabio Luzi, Corrado Carenzi, and Marina Verga

A theoretical study of medical imaging by optical tomography using a radiative transfer model, H. Trabelsi and R. Ben Salah

Mathematical relation between Thermal skin surface data and ist electrical counterpart, Marc Piquemal, Benjamin Baran, Andre Lheureux and A Hermosilla

Emissivity of the popular dental materials, M. Dabrowski, R. Dulski, P.Zaborowski and St. Zmuda

Environmental Applications

On the use of an infrared camera for the measurement of temperature infires of vegetative fuels, Frédéric Rinieri, Jacques Henri Balbi and Paul Antoine Santoni

Experiments on scale reduction in infrared land-mine detection, Alberto Muscio, Luca Tarozzi, Mauro A. Corticelli

Air borne laser IR thermographic system for detecting gas leaks, V.Vavilov, O. Ershov and A. Klimov

Monitoring of the Degradation Dynamics of agricultural films by IR Thermography, P. Mormile, L. Petti, M. Rippa , B. Immirzi, M. Malinconico

Non-destructive analyses of defects and effects of airborne pollutants, Giuseppe Maino, Claudio Bonifazzi, Silvia Massari, Lorenza Roversi, Chiara Selvatici and Agostino Tartari

Measurement of forest fire parameters with multi-spectral imaging in the medium infrared, Juan Meléndez, José Manuel Aranda, Antonio J. de Castro,and Fernando López

Thermophysical properties

Two-dimensional thermal analysis of organic materials by IR thermography, Junko Morikawa, Toshimasa Hashimoto

Thermal characterization of multi-layer polymer films by IR thermography, Junko Morikawa, Toshimasa Hashimoto and Roberto Li Voti

IR thermographic evaluation of thermal diffusivity anisotropy: the comparative analysis of some algorithms, V. Vavilov and V. Shiryaev

Ageing evaluation of Thermal Barrier Coating: comparison between Pulsed and Thermal Wave Interferometry, P.G. Bison, F. Cernuschi, E.Grinzato, S. Marinetti and D. Robba

Two dimensional velocity mapping in the case of three dimensional transient diffusion: "Flash" method and infrared image sequence analysis, M. Bamford, J.C. Batsale, O. Fudym and D. Reungoat

Application of the flash method to rods and tubes, Agustín Salazar, Alberto Oleaga, Fernando Alonso and Idurre Sáez-Ocáriz

Thickness measurement system of multilayer films, Christian Florin

Modeling

A semi-analytical model for the temperature distribution of thermoinductive heating, B. Oswald-Tranta, G. Wally, J. Oswald

Some peculiarities of modeling defects in composite materials, W. Swiderski and V. Vavilov

Detection of thermal bridges in insulating stratified media with thermography- A 3D transient direct model suitable to implement a total least square estimation method, M. Bamford, J.C. Batsale, D. Mourand and A. Bendada

Application of control volume numerical method in thermographic

analysis of relative material loss, S. Svaic, I. Boras

Thermal model of multilayer structure to include thermal resistance and thermal capacity, Gregor Gralevicz, Grzegor Owczarek, Boguslaw Wiecek

Modelisation of the coal pulverise combustion, M. Saadaoui, N. Mahjoub Said, H. Mhiri, G. Le Palec and Ph. Bournot

Information: email:.qirt2006@itc.cnr.it
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July 5 - 7, 2006

7th Course on the Theory and Practice of Infra Red Thermal Imaging in Medicine,
University of Glamorgan. Pontypridd CF37 !DL, UK

Preliminary Programme (subject to change):

Day 1 (Wednesday, 5 July):
Theoretical and Historical Basis of Thermal Imaging in Medicine

11.00-12.15 Registration in the (also known as 'Tâf' Building) next to 'Bytes' cafeteria

12.30-13.30 **Lunch**

13.30-14.30 History and development of IR imaging (FR)

14.30-14.40 Physical principles of heat transfer (FR)

14.40-15.20 **Break** and **check-in** to University accomodation

15.20-16.15 Principles of thermal physiology 1 (KA)

16.15-16.30 Film (cold and warm exposure)

16.30-17.20 Principles of Thermal Physiology 2 (KA)

Day 2 (Thursday, 6 July):
Clinical Applications of Thermal Imaging

09.00-09.45 Standard protocols for image capture (FR)

09.45-10.15 Provocation tests 1 (FR)

10.15-10.45 Provocation tests 2 (KA)

10.45-11.15 **Break**

11.15-12.15 Detector and camera systems (RT)

12.15-12.45 CTHERM software introduction (PP)

13.00-14.15 **Lunch**

14.15 15.15 Parallel sessions, two groups:

Film (Living body- thermoregulation)

Practical Lab image capture

15.15-15.30 **Break**

15.30-16.30 Causes of temperature increase (KA)

16.30-17.15 Causes of temperature decrease (KA)

19:00 **Course Dinne**r

Day 3 (Friday, 7 July):
Practical session capturing and analysing images

09.15-09.50 Producing a thermographic report (KA)

09.50-10.10 Discussion

10.10-10.25 Break

10.30-12.30 Practical Session:

Using CTHERM software on images taken on day 2 and guided image analysis (FR/KA)

12.30-12.45 Reliability and Limitations of IR measurements

13.00-14.00 **Lunch** - Gallery Suite ("Conservatory Restaurant")

14.00-15.00 Future developments of thermal imaging in medicine

1. Image databases and image exchange (FR)
2. Integration into hospital DICOM systems (FR)
3. Medical Education, Journals and conferences (KA)

15.00 **Close**

Registration Fee

£365 (students £200). Cheques should be made payable to The University of Glamorgan. Prior reservation is essential. Booking form below.

The fee includes:

lunch and refreshment breaks,

book on thermal imaging in medicine,

searchable CD of archived "IR Imaging in Medicine" publications.

Accommodation

Inexpensive campus accommodation is available for participants without own transport who would like to stay at the University. Check-in after 14:00. If you plan to arrive late in the evening, please let us know.

There are also some Hotels and B&Bs nearby (contact details and prices on request, see) for those with a car.

Certificate

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

August 30-September 3, 2006

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Conference Site and Hotel: Marriott at Times Square, New York City, New York, USA

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20-23 September 2006

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III International Symposium On Medical Physics
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MAIN TOPICS

Bioelectromagnetism

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V SMP is open to all persons interested in Symposium topic. To register for the Symposium, please complete the On-Line Registration Form at http//www.ismp.us.edu.pl/registration.html

SYMPOSIUM FEE

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The Symposium fee includes:
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Einladung zur
Generalversammlung der Österreichischen Gesellschaft für Thermologie

Die Generalversammlung findet am 10. Mai 2006 in den Ordinationsräumen unseres Kassiers Herrn Prim.Dr.H.Mayr in Wien 14, Felbigergasse 110, um 18.30 Uhr statt.

TAGESORDNUNG

Bericht des Präsidenten

Bericht des Sekretärs

Bericht des Kassiers

Festlegung des Mitgliedbeitrages

Bericht der Rechnungsprüfer und Entlastung des Vorstandes

Neuwahl des Vorstandes

Allfälliges

Anträge an die Generalversammlung sind mindestens 48 Stunden vor dem Termin der Generalversammlung schriftlich beim Präsidium einzureichen.

In der Hoffnung auf zahlreiche Teilnahme verbleibe ich

mit freundlichen Grüßen

Prof DDr.Kurt Ammer

Präsident der Österreichischen Gesellschaft für Thermologie

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10th Congress

combined with

9th Annual Congress of The Polish Association of Thermology

and

19th Thermological Symposium of the Austrian Society of Thermology

ZAKOPANE POLAND 15th –17th September 2006

General Information

Topics

Human body temperature, thermal physiology, applications of thermal imaging in medicine, veterinary medicine and biology.

Infra red imaging systems, software systems for thermal image processing,

Technological and practical standards.

Abstract deadline MAY 1st, 2006

Abstract form will be found in Thermology international and on the conference website

Contact ajung@wim.mil.pl

Registration Fee 300 Euros (based on room share)

Includes full board at conference hotel, and social events

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9th National Congress of the Polish Association of Thermology

19th Thermological Symposium of the Austrian Society of Thermology

Zakopane / Poland – 15th-17th September 2006

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Autors

Abstract

Return this form not later than May 1, 2006 to:

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e mail: ajung@cskwam.mil.pl

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Prof Ammer: KAmmer1950@aol.com

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Österreichische Gesellschaft für Thermologie

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