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

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Kann die Thermographie das "Regulationsverhalten" entdecken ?

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Winfried Weber beschreibt in dieser Ausgabe auf Seite 89 ff den interessanten Versuch (1), eine thermographische Technik, die in der Materialprüfung eingesetzt wird (2,3), auf die Beurteilung des Menschen zu übertragen. Ähnliche Vorstellungen hatte bereits Wiecek (4) präsentiert. Die Überlegungen Weber`s zielen jedoch in die Richtung, mittels des technischen Verfahrens der Impulsthermographie das "Regulationsverhalten" zu beurteilen.

Prinzipiell ist festzuhalten, dass in einer Regelung Information transportiert wird, um trotz vorhandener Störgrößen bestimmte Regelgrößen konstant zu halten (5). Die Vernetzung der einzelnen Regelkreis kann vielleicht als "Regulation" verstanden werden. Ob "gute Regulationsfähigkeit" mit Gesundheit, "schlechte Regulation" mit Krankheit gleichgesetzt werden kann, wie es von Seiten der Regulationsthermographie vertreten wird (6), bleibt vorerst eine interessante Hypothese.

Überlegungen zu differenten Wirkungen unterschiedlich intensiver Reize auf den Gesamtorganismus sind gerade im Bereich der Thermotherapie und anderer physikalischer Therapiemaßnahmen nicht neu (7). Allerdings ist die Regelhaftigkeit einer vegetativen Umstimmung in Abhängigkeit nicht zuletzt wegen ungenauer Definition des "Vegetativums" keineswegs gesichert. Auch die Definition von "Wärme"-bzw. "Kälte-Typen"(8,9,10) kann diese Problematik nicht lösen. Darüberhinaus bestehen zu den Effekten thermischer Reize klare Vorstellungen, die auch experimentell gut abgesichert erscheinen (9,10,11). Im Übrigen wurde auf individuell unterschiedliche Reaktionen hingewiesen (11).

Aufgabe der Thermoregulation ist es die Kerntemperatur konstant zu halten (8,12). Eine fehlerhafte Regulation kann dabei durch alle Teile des Regelkreises bedingt sein. Eine Schlussfolgerung vom Verhalten eines Regelkreises auf die Funktion der Gesamtheit aller Regelkreise, der "Regulationsfähigkeit" ist zumindest kühn.

Darüber hinaus sind auch für die Infrarotbestrahlung lokale Veränderungen der Haut- und Unterhauttemperatur, sowie Veränderung von Blutdruck und Herzfrequenz im Vergleich zu anderen wärmezuführenden Maßnahme bekannt (13,14,15). Ob eine veränderte Reaktion auf Wärmezufuhr, wie von Weber beschrieben, Ausdruck einer verbesserten Regulationsfähigkeit darstellt, bleibt bei den beschriebenen Versuchsbedingungen (Raumtemperatur zwischen 22 und 25°C) fraglich. Insbesonders erscheint es unverständlich, dass Personen in der Gruppe mit geringerer Kerntemperatur nach Wärmezufuhr mittels Infrarotblitz weniger Erwärmung der Hauttemperatur zeigen, und die Hauttemperatur 2 Minuten danach sogar noch 0,53 Grad unterhalb des Ausgangswertes liegt.

Trotz dieser Unstimmigkeiten zeigt die Arbeit von Weber, dass die Infrarotmessung der Hauttemperatur Wesentliches zu Fragen der Thermoregulation beitragen kann.

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Infrared: Detection and Discoveries in Astronomy

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Summary

Infrared astronomy is a relatively recent field of development that has complemented both optical imaging and the advancement of astronomical disciplines after the second world war such as Radio Astronomy, Ultraviolet, X ray and Microwave astronomy. Progression of infrared technology during this conflict led to spin offs that have ultimately opened hitherto unknown regions of our universe and given remarkable insight into our models of stellar evolution, and a greater understanding of the emergence of our universe.

Key words: Infra red astronomy, universe, astronomical discipline

Infrarot: Erkennung und Entdeckungen in der Astronomie

Die Infrarot-Astronomie ist eine relative junge Entwicklung, die sowohl die optische Bildgebung als auch die Fortschritte der astronomischen Disziplinen nach dem 2,Weltkrieg wie die Radio-Astronomie, die Ultraviolett-, Röntgen- und Mikrowellen-Astronomie ergänzt. Der Fortschritt in der Infrarot-Technologie während dieses Krieges öffnette den Blick in bislang unbekannte Regionen des Universums, zu Modellvorstellung der Entwicklung der Sterne und letztlich zu einem besseren Verständnis der Entstehung unseres Universums.

Schlüsselwörter: Infrarot-Astronomie, Universum, astronomische Disziplinen

Introduction

Discovered by the famed astronomer William Herschel in 1800, infrared radiation and its applications to astronomy have largely had to wait until the later decades of the 20th century until techniques of rocketry and satellite detection came to fruition. During the 1970's and 1980's, both ground based infrared and satellite detection enabled astronomers to obtain their first glimpse of an invisible universe with remarkable properties. In this discourse we would like to concentrate on both a historical and scientific perspective, outlining the growth and application of infrared technology within the astronomical field, and what subsequent discoveries have indicated about the current state of our universal environment.

The Discovery of Infrared radiation

William Herschel was probably the greatest amateur astronomer of all time, but not only was he a good observer, he appreciated the value of theory and experiment also. In his astronomical career, his insight led to many new fields of research, such as variable and double stars and the founding of modern stellar evolution, through to the devising of large catalogues outlining the positions and appearances of various objects which became the bedrock of the New General Catalogue (NGC) of extrasolar and extragalactic objects. In 1800 he was experimenting with a prism, due to his concern with the amount of heat transmitted through the filters he employed whilst observing the sun. Some filters cut down the amount of light, but became uncomfortable due to the heat they appeared to generate, and Herschel began to suspect that light of different colours had different heating powers. After admiring the range of colours in the solar spectrum, he placed three thermometers in the spectral range, but noticed that the one in the red appeared to signify a higher temperature. Acting on a hunch, he placed a spare thermometer beyond the red part of the spectrum, immediately noticing that the thermometer level climbed, indicating a source of heat or radiation at a point beyond the visible edge. He named this *dark heat (*the name *Infra red*-beyond the red- was suggested some years later), and gave the world a clue that there were invisible wavelengths of electromagnetic radiation that could have some applications to science.

The growth of a new astronomy

In the 19th century, the military had little use for infrared detectors - which at the time were little more than thermometers anyway, but various astronomers began to experiment, creating the thermocouple and the vacuum thermopile, and utilizing these instruments, infrared radiation from celestial bodies could be discerned for the first time.

The first conclusive observation in infrared astronomical detection was made by Charles Piazzi Smyth in 1856 when he employed a thermocouple to look at and detect heat from the Moon**.** In 1870, Lord Rosse of Parsonstown Ireland, the gentleman who had built the largest telescope of his day (72 inches in diameter), used a thermocouple to follow the moon through its phases and made the observation that the Moon's temperature appeared to be within a range of 450 to 500 degrees Farenheit. However, little more was added to astronomical knowledge, and infrared work detailing the moon continued up to the middle of the 20th century, as the detectors of the day could only pick up relatively nearby astronomical sources.

Infrared detection in Astronomy

Every object that has a non-zero temperature radiates in the infrared. Thus, Infrared Astronomy involves the study of just about everything in the Universe. In the field of astronomy, the infrared region lies within the range of sensitivity of infrared detectors which is between about 1 and 300 microns (a micron is one millionth of a meter). The human eye detects only 1% of light at 0.69 microns, and 0.01% at 0.75 microns, and so effectively cannot see wavelengths longer than about 0.75 microns unless the light source is extremely bright.

In the early days of infrared detection, all observations were ground based, and a system of photometric nomenclature has built up around these observations which refer to the specific wavelength of IR light. Much of this delineation is still in use today, and the various IR wavelengths follow the pattern set out below :

Wavelength(mm)	Photometric Letter
1.1-1.4	**J**
1.5 - 1.8	**H**
2.0 - 2.4	**K**
3.0 - 4.0	**L**
4.6 - 5.0	**M**
7.5 - 14.5	**N**
17 - 40	**Q**
330 - 370	**Z**

As can be seen, there are large gaps between specific wavelengths where absorption in the atmosphere makes infrared observing impossible for ground based studies - thus making the development of satellite borne equipment an imperative.

Many objects in the universe which are much too cool and faint to be detected in visible light, can be detected in the infrared. These include cool stars, infrared galaxies, clouds of particles around stars, nebulae, interstellar molecules, brown dwarfs and planets. For example, the visible light from a planet is hidden by the brightness of the star that it orbits. In the infrared, where planets have their peak brightness, the brightness of the star is reduced, making it possible to detect a planet in the infrared.

Obviously, before any further progress could be made in the field of astronomical IR imaging, something more sophisticated than a thermocouple had to be utilized. In 1947 Golay built a subtle form of pneumatic detector for infrared radiation. The radiation entered a cell through a transparent window, heats a trapped gas inside which expands against a rubber diaphragm, and a beam of light reflecting off this diaphragm is slightly deflected, giving an estimate of the function of the radiation entering the cell. Golay cells were in extensive use in laboratories for many years thereafter

Instruments for detecting infrared radiation, to date, include heat-sensitive devices such as thermocouple detectors, bolometers (some of these are cooled to temperatures close to absolute zero so that the thermal radiation of the detector system itself is greatly reduced), Fotovoltaic cells, and photoconductors. The latter are made of semiconductor materials (e.g., silicon and lead sulfide) whose electrical conductance increases when exposed to infrared radiation. Coupling infrared detection to photography was another challenge that was gradually overcome by the middle years of the 20th century, and the employment of photocathodes and photometers all increased the range of objects now under scrutiny by budding infrared astronomers

Further advances made it possible to use detectors of Lead Sulphide and Germanium doped with various elements such as Copper, Galium and Mercury. The doping occurs when the crystals of Germanium are introduced to the impurities of these other elements and are cooled by immersion in liquid helium, liquid neon or liquid hydrogen. The introduction of photometers containing these detectors and "Dewars" to contain and cool them led to many advances in infrared astronomy, especially the recognition and cataloguing of sources such as the CalTech 2 Micron survey (CIT 1 - CIT14) and the Infrared Catalogue(IRC) by Neugebauer, Martz and Leighton which contained 5612 sources of IR radiation. These sources have now being extended by such satellites as the Infrared Astronomical Satellite, the Infrared Space Observatory, SPIRIT II and the NICMOS (Near Infrared Camera, Multi Object Spectrometer) camera on the Hubble Space Telescope.

A New Window on the Universe - Satellite Imaging

One of the first satellites to utilize infrared imaging was TIROS, or the Television and Infra Red Observation Satellite, part of a series of U.S. meteorological satellites, the first of which was launched on April 1, 1960. Although aimed at Earth, the implications for infrared imaging of universal sources was obvious. The TIROS satellites comprised the first worldwide weather observation system. Equipped with specially designed miniature television cameras, infrared detectors, and videotape recorders, they were able to provide global weather coverage at 24-hour intervals. The cloud-cover pictures transmitted by the TIROS craft enabled meteorologists to track, forecast, and analyze storms. From 1969, a series of advanced weather satellites known as Nimbus largely supplanted TIROS, but projects calling for IR satellites that looked for extraterrestrial sources would soon follow.

A great leap forward in our understanding and detection of infrared objects in the universe occurred on January 25, 1983 when the Infrared Astronomical satellite (IRAS) was launched. During its ten months of operation, IRAS scanned more than 96 percent of the sky four times at four infrared bands centered at 12, 25, 60 and 100 microns, increasing the number of cataloged astronomical sources by almost 70%. The IRAS mission has had a major impact on almost every area of astronomy, from the solar system to the furthest galaxies.

The Infrared Astronomical Satellite (IRAS) was a joint scientific project sponsored by the United Kingdom, the United States, and the Netherlands. IRAS' mission was to map the entire sky at infrared wavelengths, and the satellite was the first such man made object to discover a comet. The comet, IRAS-Araki-Alcock was named for the probe and two co-discovering astronomers. During its lifespan, IRAS observed 20,000 galaxies, 130,000 stars and 90,000 other space objects and star clusters. IRAS' most famous discovery was that of a new type of galaxy, a starburst galaxy. In starburst galaxies, new stars are forming more rapidly than in other types of galaxies.

In addition, IRAS found that comets are dustier than previously thought and that dust from comets fills the Solar System - a direct link to sporadic meteors and their observations from Earth by amateurs. Larger debris also attracted the attention of the satellite when it detected useful infrared data for 2004 asteroids, in addition to detecting the zodiacal dust bands - bands of infrared emission that girdle our solar system which are likely to be debris from asteroid collisions, rather than left over dust from the formation of our solar system which some astronomers had theorized .

Some of the seminal results from IRAS involved evidence of zodiacal dust bands around other stars, and indirect evidence for other solar systems by finding a disk of dust grains around the star Vega, in addition to detecting disks of material around several other stars. Its penetrating vision also enabled astronomers to study several probable protostars embedded in clouds of gas and dust, and found that some Bok globules, areas of dense material within ionized nebulae, contain protostars. IRAS also cataloged thousands of hot, dense cores within clouds of gas and dust which could be newly forming stars, in addition to observing over 12,000 variable stars. The wealth of data accumulated by IRAS is still perused today, and valuable contributions to every field of astronomical study continue to be made many years after the demise of this wonderful window on the invisible universe. Its daughter projects are advancing infrared satellite examination of the universe into the 21st century.

One such daughter product was the European Space Agency's Infrared Space Observatory. The Infrared Space Observatory (ISO) was an astronomical satellite that had been operational between November 1995 and May 1998. It functioned at wavelengths from 2.5 to 240 microns, and capitalized upon the success of IRAS and extended the range of satellite bourne observations in the infrared range of the electromagnetic spectrum. The scientific instruments for the satellite were developed by multinational teams, from France, Germany, the Netherlands and the United Kingdom. The satellite was developed, manufactured, integrated and tested by an industrial consortium made up of 32 companies, mostly from Europe, headed by Aérospatiale, France. On average, ISO performed 45 observations per revolution, eventually successfully completing well over 26.000 scientific observations.

The 0.6 metre telescope onboard the ISO fed infrared beams via a pyramidal mirror to four instruments. The fields of view and the selection of wavelengths were varied, to suit the nature of the object examined. To enable the maximum input to this mission, ISO was equipped with the following instruments: The Infrared Camera (ISOCAM), was the principal instrumentation, which covered the 2.5-17 micron band with two different detectors. It can be compared to a normal camera, taking pictures of the 'infrared face' of astronomical objects at a high resolution. The second instrument, the photo-polarimeter (ISOPHOT), was designed to detect the amount of infrared radiation emitted by an astronomical object. The broad range of wavelengths at which ISOPHOT operated (between 2.5 and 240 microns) allowed it to 'see' objects as cool as the clouds of dust lying among stars and galaxies, whose temperature may be just a few degrees above absolute zero (minus 273 degrees C). The third instrument, The Short-Wave Spectrometer (SWS), covered observations in the 2.4 to 45 micron band. It has provided valuable information about the little known chemistry of the Universe, since many molecules emit copiously in the infrared. Moreover, SWS has been able to find out the physical conditions of those chemical constituents, such as temperature or density. The last instrument in this array, the Long-Wave Spectrometer (LWS), was able to operate at the 45 to 196.8 micron band. LWS has focused on cooler objects than SWS. It is especially useful studying the physical condition in very cold dust clouds in the space between stars, and has rewritten much of our understanding of the interstellar medium. 1

One of the most incredible discoveries made by the ISO is the revelation that there huge quantities of water vapor in the universe. The telltale signature of water was found virtually everywhere, from starforming regions, the vicinity of stars at the end of their lives, in sources very close to the galactic centre to the atmospheres of planets in the Solar System. On the whole, scientists estimate the total amount of water in our own galaxy to be millions of times the mass of the Sun. This discovery has obvious implications for biological determinacy - a theoretical view which maintains that wherever the conditions are acceptable, then life will arise. Given that most life processes are dependant upon water, this could be one of the most exciting discoveries not only for astronomers, but for biologists too. Its broad range throughout our universe, even in areas close to active or high radiation sources highlights the appeal of infrared astronomy as a science, and its possible cross disciplinary derivations project a rosy future for this essential field of astronomical detection.

Infrared - Old and Young Stellar Objects

Inrared astronomy has many applications in stellar evolution, especially when used to study the environments surrounding young stars. Stars are born in vast stellar nurseries called Nebulae (Latin: clouds) which condense from the interstellar medium under the influence of gravity to form a new generation of bodies. Due to the presence of this dust and gas, we cannot penetrate these clouds at visible wavelengths, but the thermal radiation emerging from the warming and viscous heating of these clouds does escape into the universe at large, and tells us much about the secret world of star birth. Such stellar nurseries as T Tauri, R Monocerotis and the Orion nebulae have yielded a great deal of scientifically valuable information which has improved our models of stellar evolution, leading to the introduction of Herbig- Haro and Becklin- Neugebauer objects into the rich pantheon of astronomical delights. These are the circumstellar dust and gas shells which surround young stars which have recently (1 million years ago) become radiative due to nuclear synthesis in their cores, or delineate areas in nebulae where new stars are revealing themselves as tentative areas of infrared emission close to bright visible sources - indicating the presence of a newly formed star breaking out of previously hidden areas of dense gaseous matter - akin to Bok globules which radiate entirely in the infrared, yet reveal themselves to optical telescopes as dense knots of material within ionized nebulae.

Other IR objects underpin our understanding of aged stars, with the IR emission being observed to come from circumstellar dust grains of carbon, graphite and silicon. Two such examples are NML Cygni and NML Tauri (after Neugebauer, Martz and Leighton) which have dust shells so thick that visible light hardly escapes to space at all - it is only their infrared excess which gives them away. Such stars are commonly known as Cocoon stars, though what type of star and age being portrayed here is debated. Their spectral characteristics indicate that they are class M6 Ia - the largest and coolest supergiant stars. Such stars do produce a wealth of carbonate and silicate grains due to core convection, mixing and production of heavy elements which find their way into the extended outer envelopes, so these circumstellar shells are an indication of this underlying process indicating an older star rather than a younger partly obscured entity like the Becklin - Neugebauer objects. The infrared radiation is emitted by electrons in a free - free process, and its characteristic spectral bump at IR wavelengths indicates the presence of cool silicon grains rather than hot ionized gasses - another indication of stellar longevity. Additional evidence for the late spectral type of these stars is indicated by the example of R Coronae Borealis - a famed variable star which is studied by many amateurs. R CrB undergoes substantial dimming at irregular periods, and when it does so, the star has an infrared excess indicating the presence of carbon dust grains. The production of these grains in the outer envelope of the star results in a sudden dimming in visible brightness, yet the radiation is absorbed and re emitted by the grains in IR wavelengths until the dust is dispersed and the visible component reasserts itself.

The application of infrared techniques to such systems is enabling astronomers to see into the nurseries and death shrouds of stellar systems, and uncovering some of the few remaining mysteries of stellar evolution at these crucial times in the lives of stars.

Infrared observations of our galaxy and others

In the infrared, astronomers can gather information about the universe as it was a very long time ago and study the early evolution of galaxies. As a result of the Big Bang (the tremendous “explosion” which marked the beginning of our Universe), the universe is expanding and most of the galaxies within it are moving away from each other. Astronomers have discovered that all distant galaxies are moving away from us and that the farther away they are, the faster they are moving. This recession of galaxies away from us has an interesting effect on the light emitted from these galaxies. When an object is moving away from us, the light that it emits is “redshifted”. This means that the wavelengths get longer and thereby shifted towards the red part of the spectrum. This effect, called the Doppler effect, is similar to what happens to sound waves emitted from a moving object. For example, if you are standing next to a railroad track and a train passes you while blowing its horn, you will hear the sound change from a higher to a lower frequency as the train passes you by. As a result of this

Doppler effect, at large redshifts, all of the ultraviolet and visible light from distant sources is shifted into the infrared part of the spectrum. Therefore, the only way to study this light is in the infrared. Infrared astronomy will provide a great deal of information on how and when the universe was formed and what the early universe was like.

Due to the dust and gas that lies between the stars, observations of our Milky Way galaxy are stymied by intervening matter which is opaque to visible light. Recent observations by the United Kingdom Infrared Telescope (UKIRT) and the Infrared Astronomy Satellite (IRAS) in addition to the ISO, have unveiled our galactic home by revealing the distribution of this dust and gas and outlining objects of interest such as the infrared sources surrounding a possible supermassive black hole at the centre of the Milky Way. IRAS revealed for the first time the nature of the core of our galaxy and discovered infrared “cirrus” (wisps of warm dust) in almost every direction of space, outlining the distribution of interstellar material within the solar neighbourhood. One of IRAS’ greatest discoveries was its revelation that our galaxy is a barred spiral galaxy - a galaxy which has an elongated central bar-like bulge from which its spiral arms unwind, rather than the standard Sa or Sb type spiral it had always been assumed to be.

To further the interest in the galactic centre generated by the IRAS data, the next satellite mission was dedicated to penetrating deeper into the enigma at the centre of the Milky Way. The Spatial Infrared Imaging Telescope, SPIRIT III, was the primary instrument for gathering mid-infrared data about our galaxy during the Midcourse Space Experiment (MSX) mission. SPIRIT III was a 33-cm aperture telescope with a five-color, high-spatial resolution, 4.2 to 26 µm multi-spectral radiometer and a six-channel, 2.5 to 28 µm Fourier transform spectrometer.

The MSX gathered data on the Galactic Center. The infrared can peer through the dense obscuring dust that hides the Galactic center in the optical. The near-infrared is sensitive to the photospheric emission from the very large number of cooler stars seen toward this region, and also gives us a glimpse of the mass of stars and gas that comprise the very center of the Milky Way. The mid-infrared is ideal for measuring the thermal emission from the cool dust in nebular ionized (H II) regions and molecular clouds, producing the extended clumpy and filamentary emission surrounding the center, yet the central engine which generates enormous amounts of synchrotron energy and IR emission remains elusive. However, infrared astronomers and those from other astronomy disciplines have collaborated on imaging the centre of our galaxy to produce a remarkable profile of the galactic nucleus which has delineated several individual sources of radio, x-ray, ultraviolet and infrared objects, revealing a dynamic picture of events at the centre of the Milky Way that are adding to our understanding of the evolution of galactic nuclei.

What we have uncovered in regard to our galactic neighbourhood has led us to examine other galaxies at infrared wavelengths - though none in our locality are as spectacular as active or quasar type sources in deep space. One of the brightest IR galaxies does reside relatively closeby and is a prime example of an active galaxy. This source is M82 a strange galaxy about 8 million light years away which appears to be undergoing extremely widespread star forming activity and contains a high percentage of supernova remnants. The IR excess of M82 is being emitted from enormous clouds of hydrogen gas and carbon / silicate dust surrounding these “starburst” regions, indicating the source of IR radiation but not fully explaining why a well developed galaxy like M82 would suddenly undergo this scenario - unless it has recently collided with another galaxy, though evidence on this score is very weak.

These thermal sources are vital to our understanding of star formation within galaxies at differing time periods since the big bang, and consequent evolution of galactic types, and give added sagacity to our modeling of galaxies and their emergence in the early universe as we indicate below.

Infrared observations of our Universe

Infrared astronomy has opened up a whole new universe, especially with regard to our understanding of Quasars and BL Lacerta type objects. These are galaxies with extremely active nuclei, possibly containing a supermassive black hole at their centres which powers the incredible radiative output of these monsters. It was once imagined that the IR excess was generated by the same model as the radio and x ray output of such objects - synchrotron radiation, but it appears more likely that such powerhouses are surrounded by interstellar matter, perhaps in great quantity which re-emits the energy of the central source in IR. Recent imaging with the HST has revealed several galactic nuclei suspected of containing a supermassive black hole to be associated with gas and dust to such an extent that visual imaging near the central regions is out of the question, yet infrared detection has led us take a glimpse into the centre of such galaxies by revealing the clouds of dust and gas in close proximity to such an energetic source. There is some evidence at infrared wavelengths that quasars are variable in output, and some radiate mainly at IR wavelengths - again bolstering our models which invoke clouds of dust and gas on extremely large scales. Many such bodies were formed when our universe was very young, and infrared detection of them has fine tuned, not only our standard models of galaxy formation and the evolution of a homogeneous universe of gas formed after the Big Bang, into a universe filled with galactic objects; but facilitated greater understanding of the nature of galactic nuclei and the power sources that are found there. Most early type galaxies radiate strongly in IR emission due to hidden “starbursts”, - formation of huge numbers of stars inside the hitherto unseen environment of cool gasses within these galaxies. Studies in IR have led to the proposal of models which reveal how starbursts within early galaxies led to the coalescence of star clouds and central regions into denser states leading to the production of supermassive black holes.

Though less powerful than their quasar cousins, IRAS detected about 75,000 Starburst galaxies - galaxies which are extremely bright in the infrared due to intense star formation. It was found that many of these starburst galaxies have “superwinds” emerging from their centers due to the large number of supernova explosions which occur in these galaxies. As a corollary to this insight, IRAS also examined the strong infrared emission from interacting galaxies and identified areas of emission detailing starbursts along the lines of interaction The satellite also took a long hard look at the distant universe, and gave a glimpse of the emerging universe of galaxies about 12 billion years ago by its detection of IRAS F10214 + 4724 - at the time of this discovery, this distant galaxy candidate was the most luminous object known in the universe by a factor of two. Most of these discoveries have been followed up in remarkable detail by the ESA’s Infrared Space Observatory, and our understanding of these sources and their modeling continues to progress.

Infrared detection has also played a part in the determination of how our universe arose in the first place. We have a “standard model” termed the Big Bang, and ample observational evidence to suggest that astronomers are correct in concluding that the universe originated between 12 and 14 billion years ago. The best fit evidence astronomers use to underpin this model is the 3 degree K background radiation at millimeter wavelengths, but Infrared astronomy has played its part in these observations by confirming that the colour temperature and brightness of this thermal radiation correspond in the short wavelength side of the Cosmic Microwave Background (CMB) black body peak - which lies in the far infrared.

Future trends in Infrared astronomy

Objects which can be seen in visible light can also be studied in the infrared. Thus infrared astronomy can not only allow us to discover new objects and view previously unseen areas of the universe, but it can add to what we already have discovered about visible objects. To get a complete picture of any object in the Universe we need to study all of the radiation that it emits. Infrared Astronomy has, and will continue to add, a great deal to our knowledge about the Universe and the origins of our Solar System.

NASA has recently given ground based infrared astronomy a boost by instituting a new airborne observatory called SOFIA (Stratospheric Observatory For Infrared Astronomy) after the demise of funding during the early 1990’s for the old Kuiper Infrared Observatory. Based at NASA’s Ames research Laboratory in California, SOFIA is part of NASA’s “Origins” research programme which over the next few

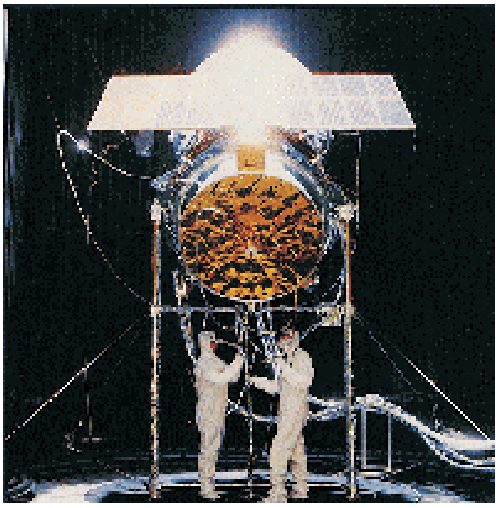

Figure 1
IRAS satellite

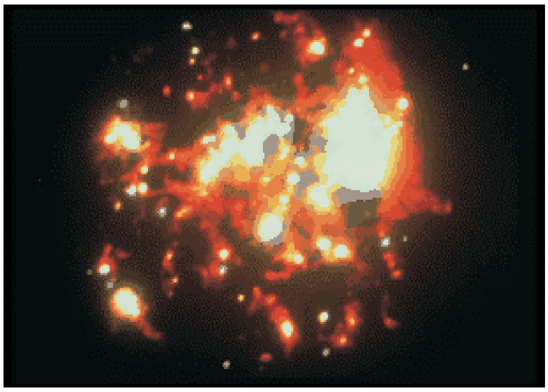

Figure 4

IRAS widefield image of the Orion nebulae M42
(Credit:
Infrared Processing and Analysis Center, Caltech/JPL; USA)

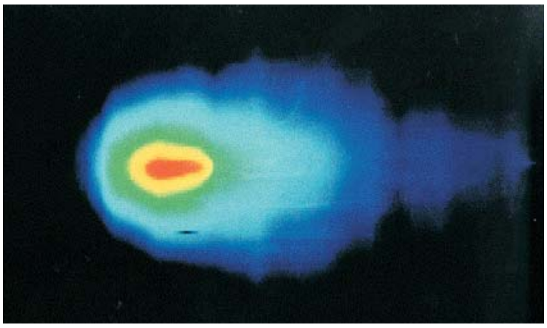

Figure 2
Comet Iras-Araki-Alcock was discovered by the Infrared Astronomical Satellite (IRAS) and made the closest known approach to earth of any comet within the last 200 years. This color image shows part of the 200,000 km long tail of warm dust stretching out behind the comet.

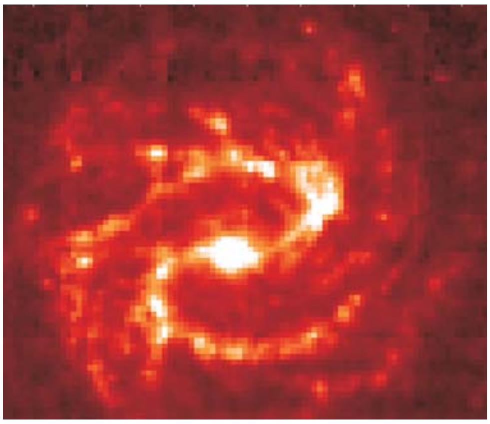

Figure 5
An ISOCAM image of Messier 83, taken through the LW2 (7 micron) filter with a 6 arcsec pixel field of view. The spiral arms, containing the star forming regions are very prominent due to emission from dust particles and Polycyclic Aromatic Hydrogen (PAH) molecules.
(Credit: ESA/ISOCAM, Rouan,D. et al; JAF 1996)

Figure 3
The galaxy pair Messier 51
(Atlas Image obtained as part of the Two Micron All Sky Survey (2MASS), a joint project of the University of Massachusetts and the Infrared Processing and Analysis Center/Calif ornia Institute of Technology, funded by the National Aeronautics and Space Administration and the National Science Foundation).

decades of the 21st century will enable scientists from all disciplines to delve into the questions of life, the universe and everything - hopefully with some success!

Supplementing these pursuits is the Two Micron All Sky Survey (2MASS), surveying the entire sky in the near-infrared from Mt. Hopkins in the United States and Cerro Tololo in Chile. The cameras on the two automated 1.3-m telescopes observe in three channels, J, H, and

K, simultaneously, using HgCdTe detector arrays, sampling the sky in 6°´ 8.3 o strips. The 2MASS Production Processing System provides images and source extractions with precise photometric calibration and astrometric positioning. Since the inception of the Infrared Space Observatory by the ESA in 1995 and the return of huge amounts of data on the infrared universe which is still being sifted and analyzed to date, the applications of space observatories to infrared astronomy will continue to play a vital role.

As long as there are fresh objects to study, there will be a demand for infrared observations of such objects. Infrared has led us to a greater understanding of many phenomena within our universe, and with the increasing advent of infrared detection from space bourne telescopes, we are expanding the horizons of astronomical understanding as we peer into the hidden worlds of stellar births, the deaths and production of elements within massive stars, and the sleeping giants - black holes - and their effects upon their surrounding environment within our galaxy and others. Infrared detection in astronomy will continue to make valued contributions to our understanding of the cosmos as we go forward into the 21st century.

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Thermographic characterization of chilblains and the therapeutic effects of topical taurine

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Summary

The aims of this study were : a) To elucidate the physio-pathology of chilblains and b)To test the therapeutic effects of topical taurine.

Methods: a) Thermograms were obtained before, and every 5 min for 30 min after 10 sec immersion of both feet into iced water (4-7°C); once weekly, and 4 times during the summer months, when asymptomatic in a subject with history of chilblains and compared to that of a normal subject.

b) Therapeutic effects of topical taurine solution were documented thermographically and photographically at weekly intervals in the same chilblain subject during the symptomatic phase. One side served as the comparative control: the left foot was immersed in warm taurine solution (40-43 °C), the right in warm water- (40-43°C) daily for 20 minutes during the first week, and both feet in warm taurine solution the second week.

Results: a) Areas affected by Chilblains even during the asymptomatic phase are characterized by significantly lower baseline temperature and impaired temperature recovery following cold challenge compared to a normal volunteer. b) Topical taurine improved the baseline temperature and also the rate of temperature recovery, with complete remission of pain, and color normalization.

Conclusion: Chilblains can be considered to be a neurovascular disorder with impaired vasodilatation. Topical taurine offers chilblain sufferers a totally innocuous but predictable and effective relief from this condition.

Key words: Chilblains, thermography, pathogenesis, treatment, topical taurine.

Thermographische Charakterisierung von Frostschäden 1.Grades und die therapeutische Wirkung von topisch appliziertem Taurin

Das *Ziel der Untersuchung* war a.) die Klärung der Pathophysiologie von Frostschäden 1.Grades und b.) die Überprüfung des Effektes von topisch angewendeten Taurin.

Methodik: a.) Thermogramme beider Füße wurden vor und alle 5 Minuten über insgesamt 30 Minuten nach einem 10 Sekunden dauernden Tauchbad der Füße in eiskaltem Wasser (4-7°C) aufgezeichnet. Dies geschah einmal wöchentlich insgesamt 4 mal während der Sommermonate bei einer asymptomatischen Person mit anamnestisch angegebenen Erfrierungen 1.Grades und einer gesunden Kontrollperson.

b) Die therapeutischen Effekte einer topisch angewendeten Taurin-Lösung wurde thermographisch und photographisch bei derselben Person mit Frostschaden während der symptomatischen Phase im wöchentlichen Abstand dokumentiert. Eine Seite diente als Kontrolle, wobei der linke, symptomatische Fuß während der ersten Woche täglich 20 Minuten lang in warmer Taurin-Lösung (40-43 °C) und der rechte Fuß in warmen Wasser (40-43°C) gebadet wurde. In der zweiten Woche wurden beide Füße in der warmen Taurinlösung behandelt.

Ergebnisse: a) Regionen, die 1.-gradige Erfrierungen erlitten haben, sind auch in der asymptomatischen Phase durch signifikant geringere Hauttemperaturen und einer verzögerten Wiedererwärmung nach Kaltwassertest im Vergleich zu einem gesunden Freiwilligen gekennzeichnet. b) Topisch appliziertes Taurin erhöht die Hauttemperatur und fördert die Wiedererwärmung bei gleichzeitiger Schmerzbefreiung und Normalisierung der Hautfarbe.

Schlussfolgerung: Der Frostschaden 1.Grades kann als neurovaskuläre Erkrankung mit verminderter Gefäßerweiterung betrachtet werden. Topisch angewendetes Taurine bietet sich bei dieser Erkrankung als gefahrlose und wirksame Therapie an.

Schlüsselwörter: Frostschaden 1.Grades,, Thermographie, Pathogenese, Behandlung, topisches Taurin.

Introduction

Chilblains (erythema pernio) represents one of the mildest forms of cold injury of the skin. They can occur in damp, cold climates, but not in very cold dry climates, and though it is not a life threatening condition, it can be disabling enough to interfere with well-being. Because the pathogenesis remains obscure, no effective cure is available. Although vasodilators such as nicotinic acid, nicotinamide, phenoxibenzamine, nicotinate, nicotinyl alcohol and inositol, calcium or vitamin D have all been advocated, results are unpredictable and generally disappointing, apart from the prospect of considerable side effects .

In order to gain understanding of the pathophysiology thermographic evaluation of the temperature recovery following a brief cold challenge was undertaken. In the course of our experimental evaluation of the central nervous system the protective effects of systemically administered taurine, and its vasodilating effects were observed, for which reason it was thought intuitively that it could be an effective and harmless therapeutic agent if topically applied for childblains.

Material and Methods.

a) Pathogenesis of chilblains

In an effort to elucidate the physiopathology of chilblains the temperature recovery after a brief challenge of cold exposure in a 61 years old male with chilblains of the feet (symptomatic for the past 5 winters on the left side, and for the past2 winters onthe right) was compared to that of a 30 years old normal male, both obtained concurrently on the same day once weekly 4 times during the asymptomatic warm months of June-July 1997.

Baseline bilateral feet thermograms were obtained at rest, following 15-20 minutes equilibration time at ambient temperature of 27-28°C. Both feet were immersed in a bucket with iced-cold water (4 – 7°C) for 10 seconds, the feet were dried by gentle blotting with a dry towel.

Bilateral feet thermograms were obtained at 3 minutes and every 5 minutes after the cold challenge for a total of 30 minutes.

Temperatures were measured at the mid portion of the dorsal aspect of each toe and the data was computed weekly on alternate sides.

b) Therapeutic effects of Taurine

Three weeks after the symptomatic onset of the chilblain on the left foot (2 weeks on the right), and coinciding with the typical painful redbluish discoloration (worst on the left side), baseline prior to topical taurine thermographic (both control and cold challenge) and photographic recordings as were obtained at weekly intervals after initiation of therapy.

I) During the first week the left foot was inserted into a plastic bag containing about 150 ml of taurine solution, and plain water for the right foot; both feet were then immersed into a container with warm water (40-43°C) for 20 minutes once a day during the first week.

II) During the second week both feet were inserted into taurine solution containing bags and then immersed into a container of warm water (40-43°C) for 20 minutes once a day.

Results

a) Pathogenesis of chilblains:

The baseline temperature in the subject with history of childbiains was significantly lower than in the normal volunteer; likewise the temperature recovery following a brief exposure to cold was significantly impaired and delayed, even while asymptomatic, (Table 1); both worsened during the symptomatic phase (Figure 1).

b) Therapeutic effects of Taurine

Although daily immersion of feet into warm water per se had a beneficial effect as could be seen on the right foot during the first week without taurine compared to before treatment, topical taurine resulted in improvement of the baseline temperature as well as the temperature recovery on each side (Figure 1). While the

Table 1

	CHILBLAIN				*p value	NORMAL			
	Average 5 toes (°C)		% RECOVERY			% RECOVERY		Average 5 toes (°C)	
	Mean	SD	Mean	SD		Mean	SD	Mean	SD
Baseline	32.61	0.55			0.04			33.81	0.25
ICED WATER CHALLENGE (10 secs 4-7° C)									
Post	23.77	2.78			0.77			23.85	1.35
3 mins	27.12	2.15	37.37	12.67	0.04	73.14	11.40	31.17	1.33
5 mins	27.75	2.09	44.99	12.29	0.02	87.38	8.43	32.56	1.06
10 mins	28.99	2.05	59.82	14.64	0.03	89.68	4.67	32.87	0.59
15 mins	29.76	1.76	67.94	12.40	0.02	93.35	2.88	33.15	0.51
20 mins	30.45	1.41	75.44	9.11	0.02	96.61	1.72	33.47	0.38
25 mins	30.63	1.44	77.08	10.76	0.02	95.92	2.54	33.39	0.52
30 mins	29.99	2.28	70.01	21.91	0.02	97.22	1.54	33.54	0.37

Temperature recovery following cold challenge. The baseline temperature as well as the temperature recovery even during the asymptomatic phase of childblain are significantly lower ($p < 0.05$) than in the normal volunteer. *Mann-Whitney "U" test; SD = standard deviation.

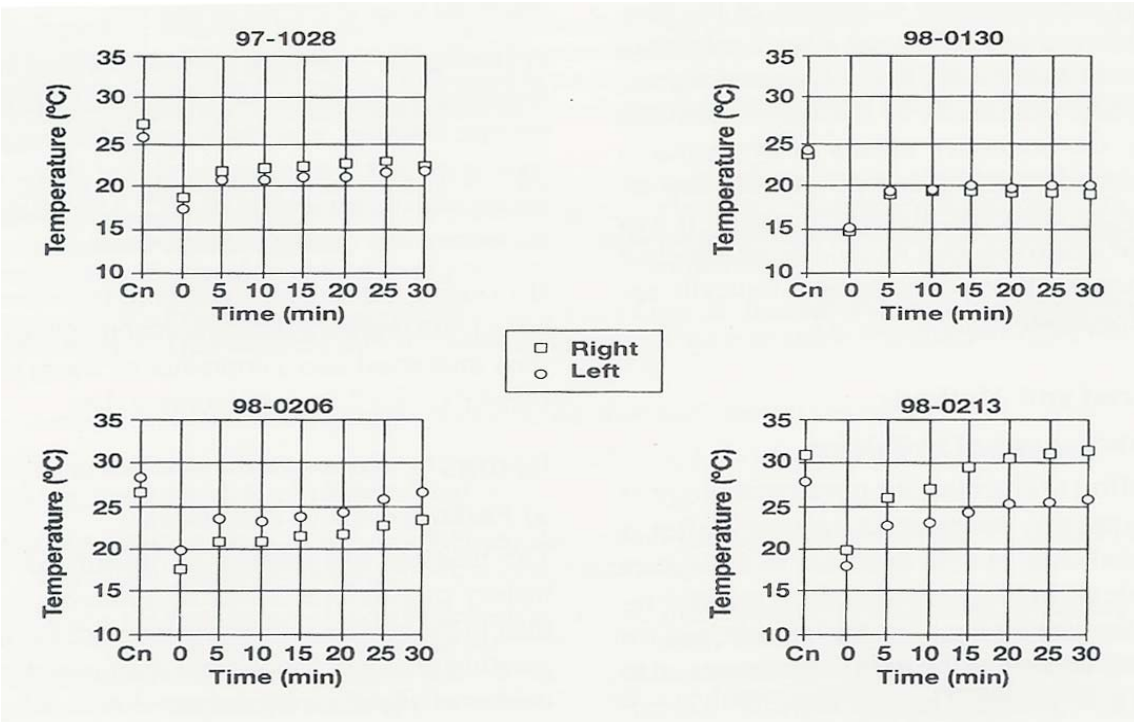

Figure 1.
Thermographic assessment of the therapeutic effects of topical taurine. (97-10-28): baseline recovery pattern before the appearance of symptoms,already showing a lower temperature than a normal subject before and an impaired temperature recovery after the cold challenge.(98-01-30): after symptoms appeared but before institution of taurine treatment, showing further impairement of the recovery pattern. The temperature recovery improvement after iced water challenge coincided with each of the treatment sides:(98-02-06) after one week of taurine to the left only; and (98-02-13) after taurine for 2 weeks on the left and 1 one week to the right, the temperature recovery of the right foot is close to that of a normal subject, compared to the persistently impaired recovery in spite of 2 weeks treatment on the left.

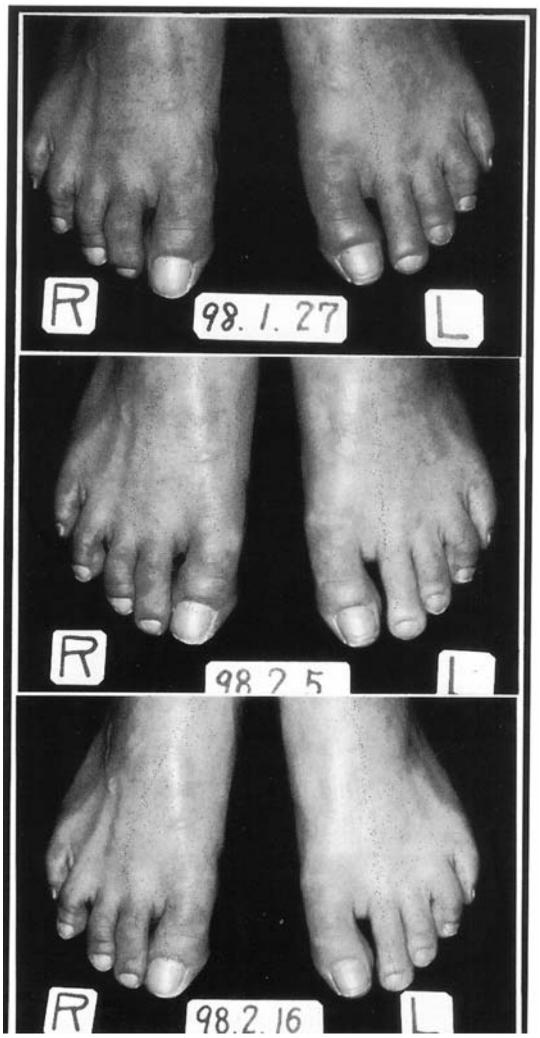

Figure 2.
Photographic documentation of the therapeutic effects of topical taurine. 98-01-27: before; 98-02-05 showing visual improvement of the color after one week of warm taurine to the left,and warm water to the right foot; 98-02-16: after 2 weeks of topical taurine to the left and one week to the right foot, the color was practically back to normal in both sides.

improvement on the left foot was noticeable during the first week but only slight during the second week, the right foot response was considerably greater than that of the left after only one week of therapy, with almost complete normalization of the pattern of temperature recovery.Thermographic changes were accompanied by clinical improvement characterized by:a) pain relief after 3 applications in both sides, in spite of the lef t side being symptomatic for longer, and the thermographic response being of less magnitude than that of the right, and b) marked improvement of the skin color with return to the normal.

The temporal course of events resulting from treatment could be appreciated even by the naked eye (Figure 2). The temperature response of the left foot continued to further improve even after maximal clinical improvement had been apparently reached, during the second week of application.

Though not included in this study, a similar result has been obtained in a second 30 years old female chilblain volunteer in Jan 1999.

Discussion

Although the study on pathogenesis is limited to only one case, observations were made during the asymptomatic and symptomatic phases of chilblains, and seem to have clearly demonstrated the impaired vasodilatation (or increased vasoconstrictor tone ?) as the underlying physiopathologic mechanism of the chilblain.

Taurine, 2-aminoethane sulfonic acid, is a beta-amino acid, chemically and metabolically stable, not a constituent of any protein, but occurring in mammalian tissues in high concentrations (1,2). Not all the mechanisms of action of taurine are known, but the effects of taurine and its precursor homo-taurine (2-amino propane sulfonic acid) are complex, including antioxidant activities (3) as well as actions on the membrane currents of a variety of tissues such as retina, neurons (4), cardiac cells, and vascular smooth muscie cells, involving calcium modulation (5) which explains the vasodilatation observed in our animal experiments with systemically administered taurine.

Minute but measurable vasodilatory effects of taurine topically applied directly on pial vessels have been reported (6).

Whether the observed therapeutic effect was only related to vasodilatation or to the antioxidant activity of taurine is not clear, but enough absorption through the skin, a natural barrier, must have taken place. This has an important implication from the stand point of development of a therapeutic agent for a dermatological condition, since side effects of systemically (oral or intravenous) administered vasodilators could be avoided.

Whether the clinical improvement was secondary only to increased blood flow or to interaction with peripheral pain receptors is not known, but whatever reason it is assumed to have been a local effect, since the color improvement and pain relief occurred in the ipsilateral side, rather than an effect on the pain pathway of the spinal cord. In this case taurine is known to play the role of a neurotransmitter (7) and the effects would have been bilateral. Although blood levels of taurine were not determined it is difficult to imagine that sufficient amounts of taurine to have a lasting central effect on the spinal cord would have been absorbed through the skin from feet immersion in taurine solution for only 20 minutes a day.

In spite of the fact that observations were limited to only two volunteers with symptomatic chilblain, the cause to effect relationship of the therapeutic effects of topical taurine seem to be well documented. During the first week, only the worst side (left) was treated with taurine, while warm water was applied to the right side; thermographically and clinically improvement was mostly on the left and minimal if any on the right (which could be attributed to the non-specific beneficial effects of daily immersion in warm water). During the second week, both feet were treated with taurine, and although further improvement on the left was noticed, the improvement on the right after only one week of therapy exceeded that of the left with two weeks, which might be congruent with the fact that the left side was the worst affected. Whether a longer treatment period on the left side would have resulted in further benefit was not addressed by the study, but since thermographically the beneficial plateau had not been reached when the observations were terminated the likelihood is real.

Thus chilblains may be considered to be a neurovascular disorder with impaired vasodilatation or increased vasomotor tone. Topical taurine offers chilblain sufferers a totally innocuous and predictable relief of symptoms.

Acknowledgments.

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Nachweis der Stabilisierung des Regulationsverhaltens nach Infrarot-A-Bestrahlung durch Impulsthermographie

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Zusammenfassung

Über einen Infrarotblitz wurde bei 24 Probanden eine bestimmte Wärmemenge auf drei differente Hautareale aufgebracht. Ein Infrarotradiometer registrierte die Temperaturveränderung über diesen Bereichen. Es konnte nachgewiesen werden, dass nach 10-maliger Bestrahlung eines Hautareals über LWK 5 sich die Regulationsfähigkeit der Haut bei gleichzeitiger Verringerung der Kerntemperaturschwankung deutlich verbessert.

Schlüsselwörter: Infrarotblitz, Regulation, Infrarot-A, Radiometer

Evidence of stabilised regulation after Infrared-A-irradiation

A determined quantity of heat was placed by an infrared flash on certain areas of human skin. An infrared radiometer recorded the change of temperature. Ten consecutive treatments with infrared-A-irradiation in the lumbar area improved the ability of autonomic regulation and reduced the range of the central body temperature.

Key words: infrared flash, regulation, infrared-a, radiometer

Einleitung

In der Industrie wird Impulsthermografie als Methode zur Materialprüfung angewendet (1). Man gibt einen Infrarotblitz auf das zu prüfende Werkstück und schließt aus dem Temperaturabbaumuster der Werkstückoberfläche auf Materialfehler.

Ist diese Messmethode in irgendeiner Form auf den Menschen umsetzbar? Nach Materialfehlern wird bei menschlichen Probanden natürlich nicht gefragt.Hier ergeben sich völlig neue Fragestellungen:

- In welcher Geschwindigkeit kann der menschliche Körper die auf der Hautoberfläche abgespeicherte Wärme abbauen?
- Kann man aufgrund der Temperaturverlaufskurve auf das Regulationsverhalten des Probanden schließen?

  A) Wie verändert sich die Temperatur der Hautoberfläche nach lokaler Erwärmung durch einen Infrarotblitz? Inwieweit handelt es sich hierbei um aktive, körpergesteuerte oder passive, physikalische Temperaturveränderungen?

  B) Wie verändert sich die Kerntemperatur nach 20-minütiger Aufwärmung des Körpers mit einem Infrarot-Strahler?

  C) Tritt nach 10-maliger Infrarotbestrahlung ein Trainingseffekt bezüglich der Kerntemperaturstabilität auf?

- Ergeben sich aus dem Temperaturverlaufsmuster Hinweise auf bestimmte Regulationsmuster?

Methodik

Als Probanden dienten 32 Patienten, die sich freundlicherweise bereit erklärten, an der Studie mitzuwirken. Fünf Patienten mussten wegen eines anfänglichen Fehlers in der Messmethodik ausscheiden, 3 Patienten brachen die Studie ab. 24 Patienten verblieben zur Bewertung .

Gemessen wurde der Verlauf der Hauttemperatur nach Infrarotblitz vor und nach Infrarotbestrahlung an drei Arealen:

- am Fußrücken des rechten Fußes
- am volaren rechten Unterarm vier Querfinger kaudal der Ellenbogenfalte
- am Rücken über dem 5.Lendenwirbel.

Die Messungen erfolgten bei einer Raumtemperatur zwischen 22°C und 25°C und einer relativen Luftfeuchte zwischen 46% und 55%. Gemessen wurde in den Vormittagsstunden zwischen 10 und 12 Uhr in einem geschlossenen, leicht abgedunkelten Raum. Die Adaptationszeit nach dem Entkleiden lag bei ca. 10 min.

Zur Messung der Hauttemperatur diente ein Pyrometer der Fa. Heimann-Heitronics (KT 15D), der mit einer zeitgesteuerten Infrarotlampe eines Infrarotkoagulators der Fa. Nourypharma verbunden war (Abbildung 3 und Abbildung 4).

Der Pyrometer KT 15D erfasst einen Spektralbereich von 8 –14µm bei Tmin –Tmax (°C)= 0-50°C. Seine Auflösung beträgt 0,1°C bei einer Messgenauigkeit von +/- 0,2°C bei einer Messzeit von 1s. Der Messfelddurchmesser i beläuft sich bei einem Messabstand von 9 cm beim K 6 Objektiv auf ca. 11mm. Der Emissionsgrad liegt bei 0,1(2).

Auf die Haut wurde jeweils ein Infrarotfleck mit einem Radius von ca. 4 cm mit einer Belichtung von 3x3 Sek. auf das Messfeld des Pyrometers projiziert und der Temperaturverlauf im Zentrum des Messfeldes registriert (1.Messung).

Hiernach fand eine 20 minütige Bestrahlung des Probanden mit einem wassergefilterten Hydrosun-Infrarotstrahler über dem Hautareal in Höhe des 5.Lendenwirbels statt. Der wassergekühlte Infrarotstrahler erzeugt bei einem Bestrahlungsabstand von 30 cm und einer Strahlungsdichte von 200 mW/cm² im Zentrum eines Bestrahlungsradius von ca. 10 cm eine konstante Hauttemperatur von 42°C. (Abbildungen 1+2).

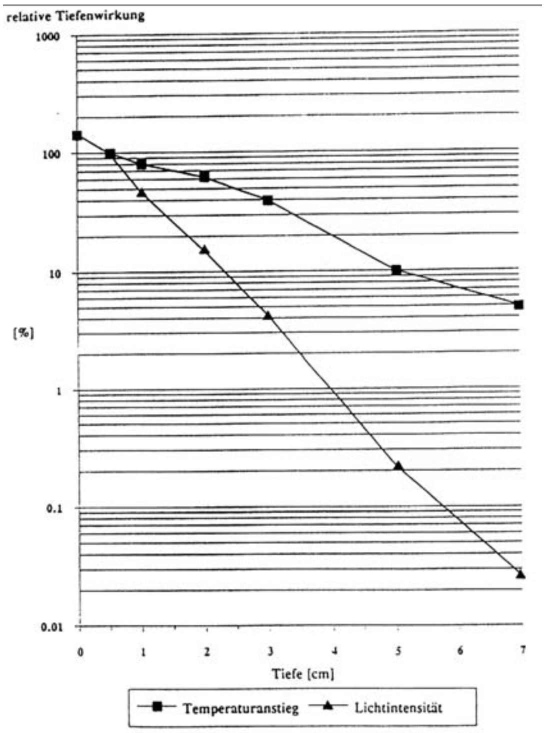

Abbildung 1
Relative Darstellung der optischen und thermischen Tiefenwirkung einer 30-minütigen Infrarotbestrahlung mit Wasserfilterung (nach 4).

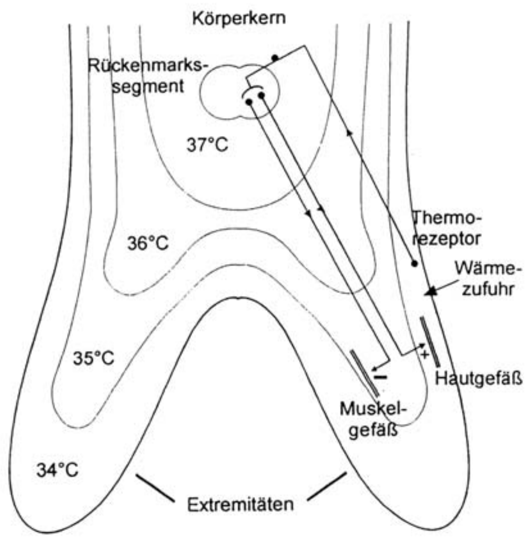

Abbildung2
Schematische Darstellung zu reflektorische Verarbeitung von kutanen Wärmereizen auf segmentaler Ebene. Es kommt zu einer Vasodilatation und Mehrdurchblutung im Bereich der Haut und der hautnahen Gewebeanteile (normale Reaktion) sowie zu einer Vasokonstriktion und Minderperfusion in der tieferliegenden Muskulatur (gegensinnige Reaktion) (nach 4)

Abbildung 3
Radiometer KT 15D der Fa. Heimann-Heitronics in Verbindung mit der Infrarotlampe des Infrarotkoagulators der Fa. Nourypharma

Abbildung 4
Durchführung der Messung am Unterarm

Eine zweite Messserie schloss sich unmittelbar an die Bestrahlung an (2.Messung).

Die Patienten erschienen hiernach zweimal wöchentlich zu insgesamt 10 Hyperthermiebestrahlungen. Bei der letzten therapeutischen Bestrahlung wurde der Patient wieder vor und nach der Bestrahlung in obiger Weise durchgemessen (3. und 4.Messung).

Vor und nach den jeweiligen Messungen fand zusätzlich eine Erfassung der Kerntemperatur über das Braun Ohrthermometer Thermoscan pro1(4) statt. Der Messbereich dieses Gerätes liegt zwischen 20°C und 42,2°C. Die Messdauer beträgt 1 s. Kontraindikationen zum Einsatz dieses Gerätes ergeben sich laut Hersteller nur bei Entzündungen des äußeren Gehörganges, bei Blutungen und Wundsekretion. Cerumen, Mittelohrentzündung und Trommelfellröhrchen stören nach Angaben einer New Yorker Kinder-Notaufnahmestation die Temperaturmessungen nicht.

Ergebnisse

Die Rohdaten sind in den Tabellen 1 dargestellt.

Kerntemperatur

Nach 10 Infrarot-A-Bestrahlungen über LWK 5 verringerte sich die Kerntemperaturschwankung (jeweils vor und nach der 20-minütigen Infrarot-A-Bestrahlung gemessen) deutlich. Die mittlere Kerntemperaturdifferenz zwischen Erst- und Zweitmessung aus 24 Patienten lag bei 0,3° C vor Therapie und bei 0,178°C nach der Therapie (Tabelle 2).

Neun der vierundzwanzig Patienten reagierten unter der Erstbestrahlung mit einem Kerntemperaturabfall zwischen 0 und 0,2 Grad (Gruppe 1) gegenüber dem Restpatientenkollektiv, welches mit einem Temperaturanstieg zwischen 0,3 und 3°C regulierte (Gruppe 2).

Die Gruppe 1 wies vor der Therapie eine mittlere Kerntemperaturdifferenz von -0,167°C, nach der Therapie von 0,088°C auf gegenüber der Restgruppe, die mit einer Kerntemperaturschwankung von 0,650°C vor der Therapie und 0,227°C nach der Therapie antwortete.

Regulationsamplituden

In allen gemessenen Gruppen fand man nach zehnmaliger Infrarot-A-Therapie eine stärkere Erwärmung der Haut unter dem Infrarotblitz und ein stärkerer Temperaturabfall nach dem Infrarotblitz (Differenz 2.Messung/1.Messung bzw. Differenz 4.Messung/3.Messung in den Diagrammen 1,2,3).

Keine Signifikanzen in den Amplitudendifferenzen fanden sich nach einmaliger Infrarot-A-Bestrahlungstherapie (Differenz 2. Messung/ 1. Messung bzw. Differenz 4. Messung / 3. Mes-

Tabelle 1
Rohdaten der Messungen

Mittelwerte Gruppe 1 (°C)	Unterarm	Fuß	Rücken
1.Messung			
T0/max	1,71 +- 0,15	1,56 +- 0,19	1,54 +- 0,13
Tmax/T1min	1,36 +- 0,27	1,17 +- 0,11	1,27 +- 0,10
Tmax/T2min	1,62 +- 0,26	1,34 +- 0,19	1,67 +- 0,19
Tmax/T3min	1,74 +- 0,20	1,39 +- 0,25	1,76 +- 0,28
2.Messung			
T0/max	1,64 +- 0,19	1,64 +- 0,18	1,46 +- 0,12
Tmax/T1min	1,36 +- 0,12	1,22 +- 0,19	1,43 +- 0,17
Tmax/T2min	1,63 +- 0,11	1,42 +- 0,25	1,80 +- 0,21
Tmax/T3min	1,79 +- 0,16	1,48 +- 0,25	1,92 +- 0,30
3.Messung			
T0/max	1,90 +- 0,29	1.98 +- 0,26	1,90 +- 0,41
Tmax/T1min	1,34 +- 0,25	1,35 +- 0,39	1,55 +- 0,38
Tmax/T2min	1,74 +- 0,41	1,51 +- 0,34	1,93 +- 0,59
Tmax/T3min	1,80 +- 0,51	1,58 +- 0,36	2,05 +- 0,63
4.Messung			
T0/max	1,86 +- 0,24	1,88 +- 0,23	1,79 +- 0,30
Tmax/T1min	1,49 +- 0,34	1,40 +- 0,41	1,86 +- 0,47
Tmax/T2min	1,81 +- 0,46	1,60 +- 0,47	2,29 +- 0,46
Tmax/T3min	1,95 +- 0,52	1,68 +- 0,53	2,51 +- 0,47
Mittelwerte Gruppe 2 (°C)			
1.Messung			
T0/max	1,71 +- 0,12	1,70 +- 0,19	1,61 +- 0,15
Tmax/T1min	1,20 +- 0,12	1,09 +- 0,36	1,34 +- 0,21
Tmax/T2min	1,44 +- 0,18	1,31 +- 0,29	1,61 +- 0,26
Tmax/T3min	1,55 +- 0,16	1,39 +- 0,35	1,77 +- 0,38
2.Messung			
T0/max	1,73 +- 0,14	1,71 +- 0,09	1,54 +- 0,14
Tmax/T1min	1,34 +- 0,17	1,26 +- 0,31	1,39 +- 0,15
Tmax/T2min	1,59 +- 0,21	1,42 +- 0,31	1,71 +- 0,24
Tmax/T3min	1,73 +- 0,23	1,53 +- 0,32	1,78 +- 0,26
3.Messung			
T0/max	1,91 +- 0,34	1,91 +- 0,32	1,76 +- 0,26
Tmax/T1min	1,38 +- 0,32	1,32 +- 0,25	1,62 +- 0,39
Tmax/T2min	1,63 +- 0,40	1,53 +- 0,29	1,97 +- 0,40
Tmax/T3min	1,73 +- 0,43	1,61 +- 0,35	2,12 +- 0,45
4.Messung			
T0/max	1,85 +- 0,30	1,94 +- 0,30	1,75 +- 0,32
Tmax/T1min	1,44 +- 0,22	1,51 +- 0,35	1,67 +- 0,40
Tmax/T2min	1,74 +- 0,30	1,71 +- 0,55	2,09 +- 0,41
Tmax/T3min	1,89 +- 0,37	1,83 +- 0,57	2,26 +- 0,48

Tabelle 1 Fortsetzung

Mittelwerte gesamt (°C)			
1.Messung			
T0/max	1,71 +- 0,13	1,65 +- 0,19	1,58 +- 0,14
Tmax/T1min	1,25 +- 0,20	1,12 +- 0,28	1,33 +- 0,17
Tmax/T2min	1,44 +- 0,22	1,31 +- 0,25	1,61 +- 0,23
Tmax/T3min	1,62 +- 0,18	1,40 +- 0,30	1,78 +- 0,33
2.Messung			
T0/max	1,70 +- 0,17	1,68 +- 0,14	1,51 +- 0,13
Tmax/T1min	1,35 +- 0,15	1,24 +- 0,26	1,40 +- 0,28
Tmax/T2min	1,61 +- 0,17	1,44 +- 0,28	1,74 +- 0,22
Tmax/T3min	1,75 +- 0,20	1,51 +- 0,29	1,83 +- 0,27
3.Messung			
T0/max	1,90 +- 0,32	1,93 +- 0,29	1,80 +- 0,32
Tmax/T1min	1,37 +- 0,29	1,33 +- 0,30	1,60 +- 0,38
Tmax/T2min	1,67 +- 0,39	1,53 +- 0,30	1,95 +- 0,48
Tmax/T3min	1,75 +- 0,45	1,60 +- 0,35	2,10 +- 0,52
4.Messung			
T0/max	1,85 +- 0,30	1,92 +- 0,30	1,76 +- 0,30
Tmax/T1min	1,46 +- 0,27	1,48 +- 0,38	1,73 +- 0,42
Tmax/T2min	1,77 +- 0,36	1,67 +- 0,51	2,16 +- 0,42
Tmax/T3min	1,91 +- 0,42	1,78 +- 0,55	2,35 +- 0,47

Tabelle 2 Kerntemperatur

Kerntemperatur	Messung 1	Messung 2	Differenz 1/2	Messung 3	Messung 4	Differenz 3/4
Gruppe 1 (°C)	36,4 +- 0,42	36,2 +- 0,46	- 0,167+-0,1	36,2 +- 0,47	36,3 +- 0,48	0,088+- 0,14
Gruppe 2 (°C)	35,8 +- 0,91	36,4 +- 0,37	0,65 +- 0,78	35,9 +- 0,52	36,1 +- 0,49	0,225+- 0,36
Gesamt (°C)	36,0 +- 0,80	36,3 +- 0,41	0,30 +- 0,71	36,0 +- 0,49	36,1 +- 0,47	0,179+- 0,29

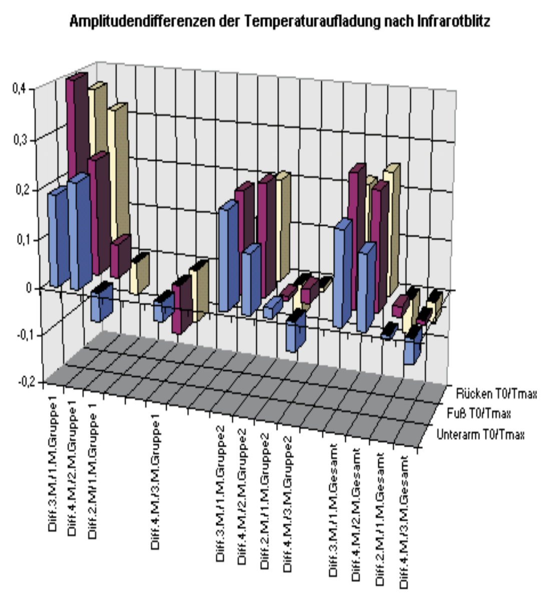

Diagramm 1 (Temperaturwerte in°C)

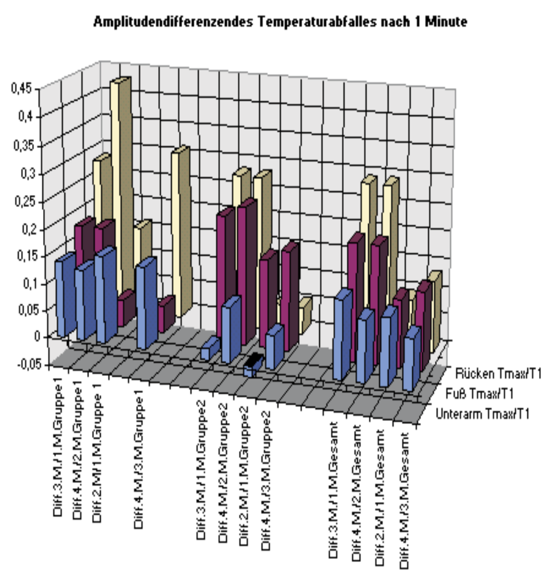

Diagramm 2 (Temperaturwerte in°C)

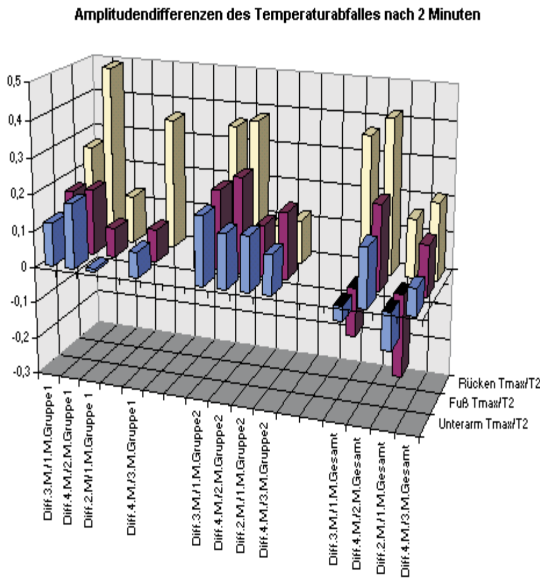

Diagramm 3 (Temperaturwerte in°C)

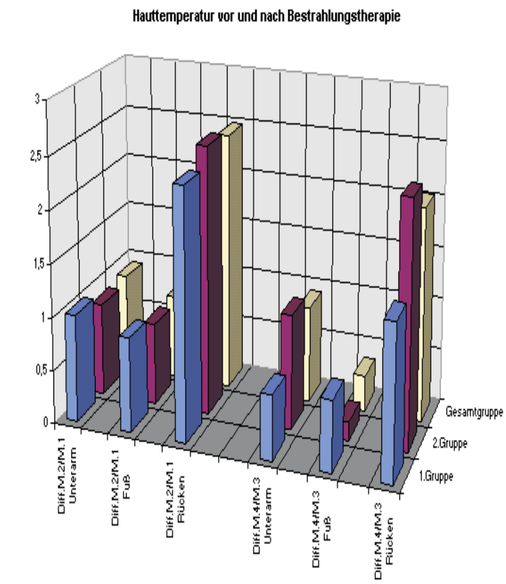

Diagramm 4 (Temperaturwerte in°C)

sung in den Diagrammen 1,2,3.). Jedoch zeigte sich hier tendenziell ein Nachlassen der Temperaturaufnahmekapazität der Haut.

Hauttemperatur

Die Hauttemperatur der Messstellen Unterarm, Fuß und Rücken erhöhte sich signifikant nach einmaliger Bestrahlungstherapie (Differenz Messung 2/Messung 1, Diagramm 4). Nach zehnmaliger Bestrahlungstherapie verringerte sich dieser Temperaturanstieg der Extremitäten und des Rückens deutlich (in Gruppe 1 mehr, als in Gruppe 2) (Differenz Messung 4/Messung 3., Diagramm 4).

Diskussion

Was passiert, wenn man drei Wärmeimpulse unmittelbar hintereinander auf ein mit Schaumstoff gepolstertes Kunststoffgewebe gibt? (Diagramm 5).

Das Gewebe erhitzt sich in kurzer Zeit um etliche Grade, kühlt innerhalb von 30 Sekunden symmetrisch zum Temperaturanstieg ab. Der Temperaturverlauf nimmt dann die Form einer Hyperbel an, die langfristig die Ausgangstemperatur nicht erreicht.

An einem Eisbein eines frischgeschlachteten Schweins sieht der Temperaturverlauf bei gleicher Temperaturbelastung anders aus.Die Hauttemperatur erhöht sich statt um 14°C lediglich um knapp 2°C und hält die Temperatur lange Zeit, ohne die Ausgangstemperatur zu erreichen (Diagramm 6).

Führt man bei einem Menschen diese Untersuchung am Unterarm durch, sieht man gegenüber der toten Schweinshaxe keinen deutlichen Unterschied. Nach 3 Minuten ist hier jedoch die Differenz zur Ausgangstemperatur durch den aktiven Wärmeabtransport des lebenden

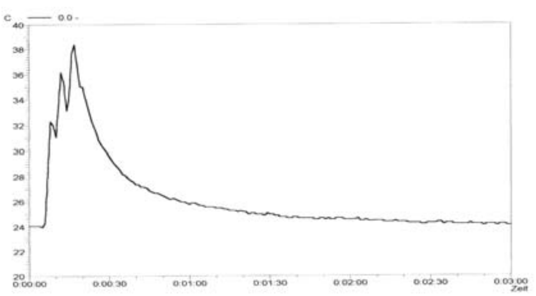

Diagramm 5

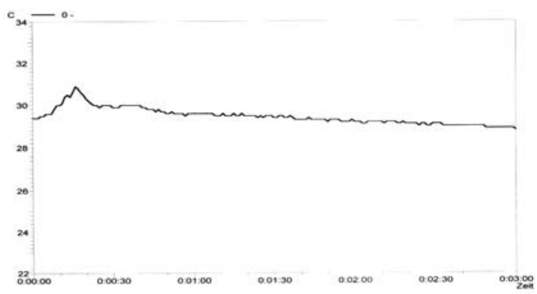

Diagramm 6

Körpers geringer als beim Eisbein (Diagramm 7).

Eine eindeutige Beurteilung des Regulationsverhaltens durch eine einmalige Wärmebeladung der Haut und die Messung der Geschwindigkeit des Temperaturabfalls scheint also unzweckmäßig.

Sinnvoll ist deshalb die Miteinbeziehung eines stärkeren Reizes auf das vegetative Regulationssystem.

Geeignet erscheint hierfür eine 20-minütige hypertherme Bestrahlung mit einem wassergefilterten Infrarot-A Gerät über dem 5. Lendenwirbel. Dieser Bereich der Wirbelsäule wird ventral von einem vegetativen Nervengeflecht, dem Plexus hypogastricus inferior überzogen und bietet sich zur Stimulation des Vegetativums an.

Geht man davon aus, dass es das Bestreben des Körpers im gesunden Zustand ist, die Kerntemperatur stabil zu halten, so könnten folgende Grundannahmen gelten:

- Je größer die Amplitudendifferenz des Temperaturabfalls in den Messreihen im Diagramm 2+3 (Differenz 3.Messung / 1. Messung, bzw. 4.Messung / 2.Messung.), und je schneller dieser Temperaturabfall stattfindet, um so besser die Regulationsfähigkeit.

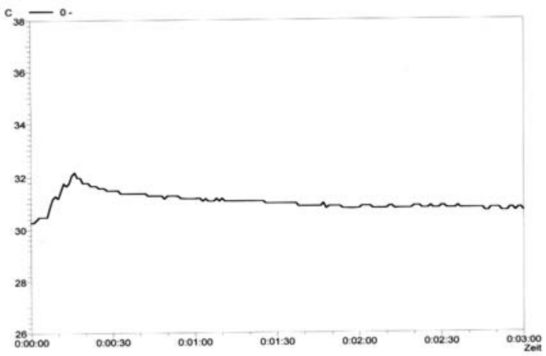

Diagramm 7

- Auch kann man eine größere Regulationsfähigkeit annehmen, je geringer die Eindringmöglichkeit von Temperatur in den Körper ist, das heißt, je höher die Temperaturaufladung der Haut unter dem Infrarotblitz sich in den Messreihen im Diagramm 1 (Differenz 3. Messung /1.Messung bzw.4. Messung / 2. Messung) darstellt.

Tabelle 3 belegt, dass die Probanden der Gruppe 1 gegenüber denen der Gruppe 2 alle oben genannten Kautelen für eine bessere Regulationsfähigkeit besitzen.

Natürlich kann streng wissenschaftlich gesehen aufgrund einer fehlenden Kontrollgruppe die beobachtete Veränderung der Regulation durchaus zufällig oder Ausdruck eines spontanen Zeitverlaufs sein. Hiergegen spricht jedoch das Ergebnis der Patientenbefragung nach Abschluss der Bestrahlungstherapie. Sämtliche Patienten der Gruppe 1 und ca. 90% der Patienten aus Gruppe 2 berichteten spontan über eine deutliche Verbesserung ihres Allgemeinzustandes.

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Tabelle 3
Unterschiedliches Regulationsverhalten beider Gruppen

	Summe der Temperaturaufladung nach Infrarotblitz (°C)	Summe des Temperaturabfalls nach 1 Minute(°C)	Summe des Temperaturabfalls nach 2 Minuten (°C)
Gruppe 1	1,73	1,34	1,4
Gruppe 2	1,03	1,16	1,56

13. Thermologisches Symposium am 13.Mai 2000

veranstaltet von der

Ludwig Boltzmann Forschungsstelle für Physikalische Diagnostik

Und der Österreichischen Gesellschaft für Thermologie

STADTPLANUNG WIEN

Magistrat der Stadt Wien, MA 18
Stadtentwicklung und Stadtplanung
Gruppe Wissenschaft

Diese Veranstaltung wird wesentlich durch die Magistratsabteilung 18 finanziell gefördert.

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Firma NBN-Eipeldauer Messtechnik.
Wien-Graz,
für die freundliche Unterstützung.

Programm

I. Einflussfaktoren der Hauttemperatur — Vorsitz. O.Rathkolb ,Wien, F. Ring, Bath

9.00 F. Ring (Bath)
Thermal imaging in medico-legal claims
9.20 Diskussion

9.25 P.Melnizky, K.Ammer (Wien)
Einfluss von Alkoholaufnahme auf die Hauttemperatur des Gesichtes, der Hände und der Kniegelenke
9.45 Diskussion

9.50 H. Mayr (Wien)
Mittlere Hauttemperatur und Thermographie
10.10 Diskussion

10.15 Th.Maca, EFJ Ring; I.Eggenberger, DM Elvins, E.Minar (Wien/Bath)
Infrarot-Thermographie des Fussabdrucks
10.30 Diskussion

10.35- 11.05 Kafeepause

II. Thermographie bei Gefäßerkrankungen — Vorsitz: K.Ammer; Wien, H.Mayr , Wien

11.05 JR Harding; Melhuish JM, Krishnamoorthy L, Wertheim DF, Clark M, Williams RJ, Harding KG (Newport)
Assessment of Raynaud’s Phenomenon Using a Hand Held Infrared Scanner
11.25 Diskussion

11.30 Th.Maca; I.Eggensberger, E Minar (Wien)
Infrarot-Thermographie von Angiodysplasien
11.50 Diskussion

11.55 A.Jung, J.Zuber, B. Kalicki, B. Wiêcek, S. Zwolenik, SJ.Klosowicz (Warsaw/Lodz)
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12.15 Diskussion

12.20 K.Ammer, E.Kern (Wien)
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12.40 Diskussion

12.50 Ende der Veranstaltung

Kurzfassungen der Vorträge

Thermal Imaging in Medico-Legal Claims

EFJ Ring

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Industrial injuries can lead to a legal claim filed on behalf of the injured patient. The lawyer will then request some specialist clinicians to examine the patient and report on the findings. Special imaging investigations may be required, and it is in this context that infra red Imaging may be requested to provide objective evidence for or against the claimed injury and its clinical effects.

More commonly in some European courts, the issue of proof of a Reflex Sympathetic Dystrophy or other pain syndrome is required.

The thermographic examination must be performed under strictly controlled conditions, so that ambient temperature, camera calibration, patient equilibration etc. can be defined. Standard views of the affected and contralateral sites are required, which should be as clear from background artefacts as possible. The processed images must be saved on the computer, so that future copies can be made which are identical, even down to the printer. Multiple copies may be required, which can not have any variation in any part of the report or the images. This may not arise until some 3-4 years after examination, making record keeping essential. Repeat examinations may also be required, perhaps one year later, when the exact protocol must be repeated. Interpretation may in some cases be simply a matter of proving asymmetry outside the published normal limits for skin temperature, providing the physician defending the patient has other clinical evidence to support the diagnosis. The thermographer may defend his images used in evidence on the basis of reputation and experience. Opposing lawyers are often limited to an internet search on thermography, and will rapidly draw on any negative publicity to the technique, some of which has appeared in the American literature over the last 20 years. Any remarks on the thermographic evidence which are supported by publication must come from peer-reviewed Journals, and the thermographer may be called upon to supply photocopies of the relevant papers.

Repetitive strain injury claims also occur, which are more difficult to prove, with opposing lawyers who refuse to accept the existence of the condition. Limited publications have been found, largely relating to the changes in temperature of the forearms after a test period of work such as typing. Stress tests are often a means of demonstrating a weakness or impairment in one limb compared to the other. Whether this be lifting or stair stepping, it is essential that the conditions are accurately recorded. If a movement or exercise is devised to demonstrate a particular weakens, the exercise must be repeated with healthy control subjects, and preferably in large enough number for publication.

Pitfalls include inadequate documentation, or standardisation of technique, and photocopied thermography reports. In the latter case, Inkjet printed images may be distorted by photocopying carried out by the lawyer's office, which the thermographer does not see until in court. For this reason multiple copies should always be offered with the report. The investigator must also refuse to discuss thermographic findings, which may be made by the opposing medical advisor " just on general principles".

When such a medical advisor succeeds in refusing the claim, the reputation of the technique and the investigators can be affected for future cases, especially if there is criticism of technique rather than interpretation.

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Einfluss von Alkoholaufnahme auf die Hauttemperatur des Gesichtes, der Hände und der Kniegelenke

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Einleitung: Alkoholaufnahme soll vor einer thermographischen Untersuchung nicht vorkommen. Für diese Empfehlung fehlen allerdings valide Daten, da der Großteil der entsprechenden Untersuchungen zu einer Zeit durchgeführt wurden, in der die quantitative Auswertung von Thermogrammen schwierig und deshalb nicht die Regel war.

Ziel der Studie: Führt die Einnahme von 2cl 40% Whisky zu einer Veränderung der Hauttemperatur des Gesichtes, der Hände oder der Kniegelenke ?

Methode: 5 Frauen und 5 Männer im Alter zwischen 23 und 58 Jahren wurden untersucht. Nach 15 minütiger Adaptierung an eine Raumtemperatur von 24°C wurden mittels des NEC San-ei Thermotracer Thermogramme des Gesichts, der Hände und der Kniegelenke angefertigt. Am folgenden Tag nahmen die Probanden vor der gleichartigen Untersuchung 2cl 40% Whisky ein. Bei 8 Personen wurden an zwei weiteren Tagen nochmals Thermographien der genannten Körperregionen durchgeführt. Die Temperaturänderungen beider Serien wurden statistisch miteinander verglichen.

Ergebnisse: Die Veränderungen der Hauttemperatur des Gesichtes (ΔG), der Hände (ΔH) und der Kniegelenke (ΔK) von einem Tag auf den anderen ohne und nach Alkoholexposition zeigt die nachfolgende Tabelle.

Bei statistisch vergleichbaren Ausgangswerte fanden sich keine signifikanten Unterschiede der Differenzwerte (2-seitige p-Werte zwischen 0,09 und 0,93). Allerdings bleibt ein Trend erkennbar nach Alkohol etwas mehr Infrarot abzustrahlen (mittlere Temperatur der Hände vor 32,4 ± 1,5°C; nach Alkohol: 33,4 ± 0,75°C) als ohne Alkoholaufnahme (mittlere Temperatur vor 32,2 ± 1,8°C;am nächsten Tag ohne Alkohol:32,2 ± 1,8 °C).

	Mit Alkohol	Ohne Alkohol
ΔG	0,07 ± 0,40	0,11 ± 0,50
ΔH	1.00 ± 1,28	- 0,08 ± 1,04
ΔK	0,29 ± 0,53	-0,11 ± 0,41

Schlussfolgerung: Innerhalb von 20 Minuten nach Aufnahme von 8ml Alkohol kommt es zu einer vermehrten Wärmeabstrahlung, die vor allem bei Personen mit habituell kalten Akren an den Händen beträchtlich sein kann. Die Temperatur bleibt jedoch symmetrisch verteilt und der Temperaturanstieg ist im Gesicht und über dem Kniegelenk klein, sodass auf Grund der Alkoholeinnahme keine Fehlinterpretation von Thermogrammen entstehen sollte.

Mittlere Hauttemperatur und Thermographie

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Die mittlere Hauttemperatur (Tsk) ist definitionsgemäß der Mittelwert der Hauttemperaturwerte. Sie wird insbesonders in der Physiologie sowie Anästhesie Intensivmedizin, aber auch in der Sportmedizin zur Erfassung der Thermoregulation verwendet. Die Tsk wird meist durch wenige punktuelle Temperaturmessungen mit Hilfe von Formeln abgeschätzt. Hier bietet sich die Thermographie einerseits zur Überprüfung dieser Formeln an. Andererseits wäre eine thermographische Messung anstelle der üblichen Schätzung ernsthaft zu überlegen. Umgekehrt könnte die mittlere Hauttemperatur geeignet sein, die thermographische Diagnostik durch die Beurteilung der aktuellen thermoregulatorischen Situation des untersuchten Patienten hinsichtlich Sensitivität der Einzeluntersuchung und Responsivität von Längsschnittuntersuchungen zu verbessern.

Die zugrunde liegenden physiologischen Mechanismen der Temperaturregulation und einige verwendete Kennzahlen kurz dargestellt.

Die Temperaturregulation des menschlichen Körpers zielt darauf ab, die Kerntemperatur konstant zu halten (2,5). Die thermoregulatorische Schale dient als Stellglied. Die weiteren Ausführungen beschränken sich auf das Verhalten in Luft unter konstanten inneren und äußeren Bedingungen (steady state).

Die Haut als “ Interface” zwischen Umgebung und Organismus ist von Einflüssen beider geprägt. Ihre mittlere Temperatur Tsk wird als Ausdruck der Thermoregulation betrachtet. Die beobachteten Gradienten der Hauttemperatur nehmen mit zunehmender Umgebungstemperatur ab. Die verschiedenen Formen des Wärmeaustausches (Leitung, Konvektion, Strahlung, Verdunstung) werden kurz erläutert. Neben der Wärmebelastung von außen spielt die Wärmeproduktion durch metabolische Vorgänge eine große Rolle. Die Wärmeproduktion durch die Skeletmuskulatur kann in Abhängigkeit von der Aktivität um den Faktor 60 schwanken. Der Einfluss dieser Größen wird durch verschiedene Formeln, die die Berechnung der Tsk aus einigen Parametern angeben, illustriert. (gelb markiert mit schwarzer Einrahmung)

Eine computergestützte Suche in der auf CD ROM vorliegenden Zeitschriften Acta Thermographica und Thermology mittels der Stichworte “mean skin temperature”, “average skin temperature” und “Mittlere Hauttemperatur” erbrachte keine relevanten Beiträge zur Überprüfung von Formeln zur Abschätzung der Tsk mittels der Thermographie.

Demgegenüber fanden sich bei einer computergestützten Suche in der Datenbank Medline mit den Stichworten “mean skin temperature” und “thermography” eine Arbeit zu diesem Thema (2), eine weitere, die einen Teilaspekt untersucht (6,7) sowie einige, die berichtenswerte empirische Daten dazu enthalten (3,4,8,9).

Choi et al (2) prüften 18 verschiedene Techniken zur Bestimmung der mittleren Hauttemperatur bei verschiedenen Umgebungstemperaturen. Entgegen vielfach gebrauchten Formeln und Empfehlungen fanden die Autoren nur solche als ausreichend genau, die mehr als 7 Hautareale zur Abschätzung heranzogen und Messwerte von Hand und Fuß einschlossen. Nicht unerwartet ist die Beobachtung der Autoren, dass selbst thermographische Punktmessungen nicht mit regionalen Durchschnittswerten übereinstimmten. Frim (4) beobachtete über eine Strecke von 5 cm bis zu 7°C Temperaturunterschied, im Durchschnitt 2-3 °C unter kühlen Umgebungsbedingungen. Choi (2) fand, dass die Korrektur der Messwerte die Genauigkeit der Formeln verbesserte, nicht jedoch individuelle Anpassung der Gewichtungfaktoren. Livingston (6) prüfte in einer Arbeit thermographisch die Genauigkeit thermometrischer Messungen der Stammtemperatur unter verschieden dicker Kleidung nach und fand einen besonders verlässlichen Punkt in der Mitte der Verbindung von Nabel und Brustwarze. In einer 2. ähnlichen Arbeit fand er, dass die Genauigkeit der Messungen Adipositas und kühle Umgebung zu geringerer Verlässlichkeit der Thermometrie im Vergleich zur Thermographie führen (7). Frim (4) konnte aber eine Abschätzung des Einflusses der Adipositas auf die Hauttemperaturmessung durch gängige anthropometrische Parameter nicht nachweisen.

Einige Studien verwendeten die Thermographie zur Messung der Hauttemperatur bei verschiedenen körperlichen Aktivitäten. Clark (3) untersuchte Läufer unter verschiedenen Umgebungstemperaturen. Er fand Unterschiede zwischen thermographischer und thermometrische Messung von bis zu 5°C. Er fand unter Belastung auch eine Änderung des thermischen Musters mit höheren Temperaturen über der Muskulatur. Verschiedene japanische Autoren (8,9) fanden thermographisch unter Ausdauertraining ein intensitätsabhängiges Sinken der Hauttemperatur unabhängig von der Schweißproduktion. Erst nach Beendigung des Trainings stieg die Hauttemperatur an.

Zur Verwendung der Tsk zur Verbesserung der Sensitivität und Responsivität der Thermographie konnten wir in den zitierten Quellen keine Angaben finden.

Die Bestimmung der mittleren Hauttemperatur mittels Thermographie sollte aufgrund der vorliegenden Daten vermehrt eingesetzt werden. Weitere Untersuchungen zur physiologischen, pathophysio logischen und thermographisch - diagnostischen Relevanz der mittleren Hauttemperatur erscheinen wünschenswert.

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Infrarot – Thermographie des Fußabdrucks

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Einleitung: Um eine beschwerdefreie Gehfähigkeit aufrecht zu erhalten ist die regelrechte Belastung des Fusses unerläßlich. Neben anlagebedingten Fußfehlstellungen sind erworbene Anomalien, insbesondere durch ungeeignetes Schuhwerk, häufig. Darüber hinaus ist es wichtig die Entwicklung eines diabetischen Fusses möglichst frühzeitig zu erkennen.

Studienziel: Mit dieser Pilotstudie untersuchten wir die technische Durchführbarkeit und klinische Anwendungsmöglichkeiten eines thermographisch ermittelten Infrarotfußabdrucks.

Patienten und Methodik: An 10 gesunden Probanden (5 Männer, mittleres Alter:53 J. und 5 Frauen, mittleres Alter: 47 J.) wurde unter standardmäßig klimatisierten Raumbedingungen von 22-24 ° C zuerst die Fußsohle, anschließend der Fußabdruck dynamisch (Gehen in Schrittfolge von 1 Sekunde) sowie statisch (1 Minute Stillstand) mittels Infrarot-Thermographie vermessen. Analysiert wurde dabei die Fußsohlentemperatur, nachfolgend die Temperatur des Fußabdrucks am Boden und dessen spezifischer Temperaturabfall.

Ergebnisse: Die Temperatur des thermischen Fußabdrucks am Boden korreliert sehr gut mit dem Ausgangswert am jeweiligen Teil der Fußsohle. Die Dauer der Nachweisbarkeit des thermischen Fußabdrucks ist wiederum direkt mit dem Körpergewicht verbunden. Anhand der Form des thermischen Fußabdrucks können spezifische Regionen erhöhten Drucks oder pathologisch erhöhter Temperatur erkannt werden.

Zusammenfassung: Die Infrarot-Telethermografie des Fußabdrucks ermöglicht rasch verfügbare Informationen in Diagnostik und Verlaufsbeobachtung von (pathologischen) Fußveränderungen.

Assessment of Raynaud's Phenomenon Using A Hand Held Infrared Scanner

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Introduction: Raynaud's phenomenon is an intermittent abnormal spasm of the arterioles of distal limbs after exposure to cold or emotional stimuli resulting in painful or cold fingers. Will et al in 1992 demonstrated that average finger to wrist temperature indices less than minus 4 acquired from an infrared camera are indicative of Raynaud's phenomenon. Infrared cameras and their inherent hardware and software are expensive and inconvenient for use in the Outpatient Clinic or General Practitioner setting.

Aim: The aim of this study was to compare the temperature index obtained from a thermal imaging camera with a hand held infrared temperature scanner.

Method: Twenty patients with suspected Raynaud's phenomenon undergoing thermology examination in a specialist clinic using an infrared camera (Aga Thermovision 782) were also assessed using a hand held infra-red temperature scanner (Exogen Dermatemp). A temperature index before and 10 minutes after a cold challenge (immersion of gloved hands in water at 20 °C for 1 minute) was calculated on the left and right hand using the average temperature of the fingers minus wrists for the thermal image and the average of 12 finger minus 8 wrist temperature measurements taken with the infrared scanner.

Results: Twelve out of the twenty patients assessed by the infrared camera and by the hand held infrared temperature scanner demonstrated index values less than minus 4, indicating Raynaud's phenomenon.

Conclusion: The use of a hand held infrared temperature scanner gives a comparable result to the 'Gold standard' thermal imaging for the assessment of Raynaud's phenomenon. This could allow for the use of hand held infrared temperature scanners in Outpatient Clinic or General Practitioner settings.

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Infrarot-Thermographie von Angiodysplasien

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Einleitung: Angeborene und erworbene Gefäßmissbildungen unterliegen je nach Dignität und Ausmass der Grunderkrankung routinemäßiger Verlaufskontrollen. Die Befunde sind dabei meist schriftlich verfasst. Fotographien sind oft hilfreich, jedoch ebenso häufig nicht genügend aussagekräftig bzw. nicht besonders gut reproduzierbar. Die Angiographie ist Goldstandard, allerdings in Anbetracht der Invasivität nur zurueckhaltend indiziert. Auch der MR-Angiographie sind Limits gesetzt.

Studienziel: Die Vorteile und Grenzen der Infrarottelethermographie zur Abklärung oder Verlaufsbeobachtung von Angiodysplasien bzw. auch vaskulärer Neoplasien zu evaluieren.

Patienten und Methodik: An unserer Abteilung für Angiologie werden jährlich etwa 50 Patienten mit unterschiedlichsten Formen und Ausprägungen angeborener oder erworbener vaskulärer Malformationen untersucht. Neben der Fotodokumentation etabliert sich die Infrarot-Thermographie zunehmend. Sie liefert einfach und nicht invasiv rasch verfügbare Zusatzinformationen, die mit anderen bildgebenden Verfahren nicht vergleichbar sind. Anhand von Fallbeispielen mit Klinik und Therapie wird dies erläutert.

Zusammenfassung: Unterstützt durch erhöhte Bildauflösung sowie mit Hilfe intelligenter Software ermöglicht die Thermographie neue Wege der (Verlaufs-) Dokumentation von Gefäßmalformationen.

Thermography in monitoring diseases of peripheral vessels

A Jung[1], J. Zuber[1], B. Kalicki[1], B. Wiecek[2] , S. Zwolenik[2], S. J. Klosowicz[3].

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2. Thermography Department, Institute of Electronics, Technical University of Lodz, Lodz, Poland.
3. Crystals Physics and Technology Section of the Institute of Applied Physics MUT,Warsaw, Poland.

Abnormalities of the veinous system can occur in the early period of life. In addition to clinical identification there is a need for diagnostic imaging methods such as Doppler ultrasonography, since other methods of imaging veinous flow are invasive.

The advantage of thermography is that it is safe and non- invasive in contrast to venography, which introduces the greater risk for the patient. On the other hand, Doppler ultrasonography may not be useful in search for changes in small vessels. Plethysmography used in those cases is disadvantaged by a high percentage of false positive results. Thermographic investigation is used in diagnosis e.g. thrombosis of venous vessels, detecting the varicosed veins of the lower limbs, spermatic cord, and the diagnosis of arteriovenous fistula patency.

The mainteance of the permeability of arterio-venous fistulas is an important task in hemodialised patients. Despite clinical observation of fistula, the Doppler ultrasonography is used in critical situations. The thermographic examination provides a possibility to determine with high accuracy limitations or lack of permeability. It is also helpful in monitoring the quality of flow.

The authors illustrate with cases showing different types of angiologic pathologies, in which a thermographic investigation was used to ascertain the diagnosis, moreover, in the monitoring of ther condition after hospital discharge.

The studies were performed with the Inframetrics ThermaCAM SC 1000 camera. The data ware processed with the ThermaGRAM 95 Pro software of Inframetrics.

Thermographie der Hände und Unterarme nach Schreibarbeiten

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Einleitung: Sharma et al. beschrieben bei 10 Patienten, die über Schmerzen beim Arbeiten an der Tastatur klagten,eine Abkühlung der Fingerkuppen nach 5-minütigem Schreiben an einer Computer – Tastatur. Einige gesunde Schreibkräfte zeigten ebenfalls einem Temperaturabfall an den Fingern nach einer gleichartigen Schreibarbeit.

Ziel der Studie: Es sollte geklärt werden, wie häufig kalte Finger bei Schreibarbeiten auftreten.

Methode: 20 beschwerdefreie Frauen wurden untersucht. Vor der Untersuchung mit einer Thermokamera (Agema 870 oder NEC San-ei Thermotracer) akklimatisierten sie 10 Minuten lang mit entkleideten Armen an eine Raumtemperatur von 24°C. Thermogramme von den Händen und Unterarmen wurden vor und nach 15minütigem schnellen Schreiben angefertigt. Messareale wurden am Unterarm, an jedem Fingerendglied und über jedem Metakarpo-phalangeal-(MCP)-Gelenk definiert.

Temperaturgradienten von der Fingerspitze zum MCP-Gelenk (TGf) bzw. zum Unterarm (TGu) wurden für jeden einzelnen Finger berechnet. Kleinere Werte als -0,5 (TGf) bzw .1,0 (TGu) wurden als patholopgisch erachtet.

Die Temperaturwerte vor und nach dem Schreiben wurden mittels Wilcoxon-Test für Paardifferenzen analysiert. Darüberhinaus wurden alle Daten in Abhängigkeit der Rauchgewohnheiten mittels Mann-Whitney-U-Test überprüft.

Ergebnisse: Die Hauttemperatur am Unterarm war nach dem Schreiben unverändert oder höher als der Ausgangswert ($32{,}2 \pm 0{,}8$ vs. $32{,}8 \pm 0{,}6$; $p<0{,}001$). Die Fingerkuppentemperatur war nur bei 61/200 Fingern höher als der Ausgangswert, alle anderen zeigten deutlich niedrigere Temperaturen. Der Temperaturabfall betrug an einzelnen Fingern bis zu 6 Grad. Vor dem Test zeigten 106 Finger einen pathologischen TGf, nach dem Schreiben fanden sich sogar 132 Finger mit einer derartigen Veränderung.

Drei Personen berichteten nach der Untersuchung, dass kalte Finger nach längerem Schreibmaschine Schreiben ihnen ein bekanntes Phänomen sei. Ein Zusammenhang zwischen Zigarettenrauchen und Abkühlen der Finger konnte nicht gefunden werden.

Schlussfolgerung: Das Abkühlen der Finger beim Schreibmaschine Schreiben scheint ein häufig vorkommendes Phänomen zu sein. Als Ursache könnte eine Vibrationsbelastung vermutet werden, die zu Vasospasmen der Fingerarterien führen kann. Dies geschieht trotz des Umstandes, dass die Wärmeproduktion durch die Unterarmstreckmuskulatur eigentlich zu einer Gefäßerweiterung führen sollte, um den Überschuss an Wärme auszugleichen.

News in Thermology

8th European Congress of Thermology

The Italian Association of Thermology (AIT) is honoured to promote the 8th European Congress and the 3rd Italian Congress that will be held in Desenzano, on the Garda Lake in September 2000.

How to reach the congress site

By aeroplane: the closest airports are Verona (km 50), Milano Linate (km 120), Milano Malpensa (km 190.)

By train: railwav line Milan-Venice (which includes also Verona).Choose the trains which stop in Desenzano,

By car: Motorway Milan-Venice (A4, which includes also Verona and Bergamo.)
Motorway exit: Desenzano.

Correspondence

All correspondence related to the congress should be sent to the Organizing Secretariat:

Essepi Studio

Via Costalunga, 14 - 25123 Brescia (Italy)

Phone: (39)030382336 - Fax: (39)030382653

E-mail: essepist@tin.it

Date and location

The congress will take place in Desenzano at the Palazzo del Turismo (Palace of Tourism), Porto Vecchio, Desenzano (Brescia), Italy, on September 3-9, 2000.

The Teaching Course will take place at the Congress Center of Thie West Garda Hotel, Via Prais,Padenghe (Brescia), Italy, on September 7, 2000.

Padenghe is located just outside Desenzano, at about 6 kms.

Registrations

For registration to the Congress and the Teaching Course send the registration form (page 109)duly filled in, accompanied by the payment of the registration fee, to the Organizing Secretariat Essepi Studio.

Forms sent without the payment of the fees will not be considered.

After the payment, Essepi Studio will send to the registered participants an invoice, that can be considered as a confirmation of the registration.

Fees

Teaching Course:
Itl. 700,000 + VAT 20% = Itl.. 840,000

This registration will include

Admittance to the scientific sessions, certificate of attendance, congress folder, coffee breaks, lunches

Congress:
After April 20, 2000
Itl. 700,000 + VAT 20% = Itl. 840,000

The registration will include

Admittance to the scientific sessions, certificate of attendance, congress folder, a copy of "Thermology international"with the abstracts of the congress, coffee breaks, lunches, welcome cocktail on September 7, social dinner on September 8

Secretariat desk

The secretariat desk will operate in the congress area according to the following timetable:

Teaching Course Secretariat (at West Garda Hotel):Thursdav, September 7,h.9.00 - 18.00

Congress Secretariat (at Palazzo del Turismo):
Friday, September 8: h. 8.00 - 18.30
Saturday, September 9: h. 8.00 - 18.30

Working language

The working language of the congress and of the Teaching Course is English. No simultaneous translation will be provided.

Coffee breaks and lunches

Coffee breaks and lunches for the Congress and the Teaching Course will be served in the congress area and will be offered to all registered participants. Tickets will be included in the congress folder.

Social Program

Thursday, September 7;. 19.00
Welcome Cocktail at West Garda Hotel

Friday, September 8 , 20.30
Social dinner

Transfers

A bus transfer service will be organized from the hotels booked through the Organisation to the congress site and vice-versa during the congress.

Hotel accommodation

Participants who wish to reserve their hotel accommodation during the congress are kindly requested to send the attached hotel accommodaton form (page 110), duly filled in, to Essepi Studio.

The hoterl accommodation form must be accompanied by the payment of the hotel deposit,corresponding to the price of one overnight stay in the chosen hotel (see rates below), plus the reservation fee (Itl. 30,000 per room).

The deposit must be net of all bank charges and will be deducted from the final bill by the hotel management.

Regular invoice of the complete payment will be issued bv the hotel management when che - cking out.

Essepi Studio will provide to send the invoice for the reservation fee

DEADLINE FOR HOTEL RESERVATION: June 1, 2000

Requests received after the deadline will be taken into consideration, but accommodation cannot be guaranteed.

No reservation requests will be accepted if not accompanied bv the deposit and the reservation fee.

Hotel Prices (B&B)

West Garda Hotel****	
Single room	——
Double room	Itl. 250,000
Double room single use	Itl. 180,000
Hotel Residence Oliveto****	
Single room	Itl. 150,000
Double room	Itl. 250,000
Double room single use	Itl. 180,000

Hotel confirmation

Essepi Studio will send a confirmation voucher onlv afterr receiving the payment of the hotel deposit and reservation fee.:The voucher will specify the name and the address of the hotel. If no rooms are available in the chosen hotel, Essepi Studio will suggest other suitable accommodations When single rooms are no inore available, double rooms single use will be assigned.

Hotel cancellations

Cancellations of the hotel accommodation must be sent in writing to Essepi Studio. Cancellations received before June 15 will be entitled to a total refund (reservation fee excluded).No refund will be made for cancellations received after June 15. Refunds will be made after the congress.

Methods of payment

Pavments of the registration fees and of the hotel deposit must be net of all bank charges and can be bv:

- Bank chequee in favour of Essepi Studio srl. The cheque must be sent together with the registration./hotel accommodation forms.
- Bank to bank transfer in favour of Essepi Studio,) srl, acccount N. 8330 of Bank: Banco di Brescia, Agency 27, Via Ambaraga, Brescia (Italy) - ABI code .3500 - CAB code 11290

A copy of the transfer receipt must be sent together with the registration / hotel accommodation forms. The transfer receipt and registration form can be sent bv fax.

SCIENTIFIC PR0GRAMME

Thursday, September 7 West Garda Hotel (Padenghe, Brescia)

09.00- 18.00 Teaching Course

19.00 Welcome cocktail

Friday, September 8 Palazzo del Turismo (Desenzano, Brescia)

09.00-9.15 Opening of the congress G. DALLA VOLTA (Brescia, Italy)

09.30-10.00 Main Lecture: Historical overview on thermography E.F.J. RING (Bath, U.K.)

10.00-18.30 Scientific sessions

20.30 Social dinner

Saturday, September 9 Palazzo del Turismo (Desenzano, Brescia)

09.00-18.30 Scientific sessions and workshop on Headache and trigemino vascular system
Chairmen: G. DALLA VOLTA (Brescia, Italy); S.GOVINDAN (Pittsburgh, USA)

POSTER DISPLAY September 8 – September 9

SCIENTIFIC SESSIONS

I. SESSION: Pain

Chairmen. EFJ. Ring (Bath, U.K.),
C. Bonezzi (Pavia, Italy),
Young-Soo Kim (Seoul, Korea)

II SESSION: Osteoarticular disorders

Chairman: K. Ammer (Vienna, Austria)

III. SESSION: Physiology of thermography: induced modification of microcirculation

Chairman: C. Bonezzi (Pavia, ltaly)

IV SESSION: ATM (joint syndrome)

Chairman: S. Ciatti (Prato, Italv)

V. SESSION: Thermographical detection of modification induced by pharmacological treatment

Chairman:
G. Orlandini (Tortonia - Alessandria, Italy)

VI. SESSION: Cortical mapping of the autonomic nervous system by thermography

*Chairman:*G. Dalla Volta (Brescia, Italy)

VII. SESSION: Sleep and thermography
Chairman: S. Govindan (Pittsburgh, USA)

VIII. SESSION: Forensic medicine

Chairmen: D. Camaioni (Rome, Italy),
G.Pari(Rimini. Italy)

IX SESSION: Vascular disorders
Chairman: A. Di Carlo (Rome, Italy)

X SESSION: Dermatology
Chairman: A. Di Carlo (Rome, Italy)

POSTERS

Poster display: September 8-9, 2000 - for all the duration of the congress

Poster discussion:
September 8, in the aftenoon

TEACHING COURSE

The Teaching Course will be held on September 17 a the Congress Center of the West Garda Hotel, Via Prais.,32 - 25080 Padenghe (Brescia), Italv about 6 kms from Desenzano).

Thee Course will deal with physiology of thermology, the central autonomic nervous svstem detection by thermography, neurological applicationi, the validity of thermography in the control of pain therapy, vascular application. peripheral neuropathy, ATM joint syndrome.

The course will be limited to a maximum number of 15 people.

3rd Polish Congress of Thermology

As reported in the last issue of this journal, the Polish Society of Thermology will organize their 3rd Congress in Djerba, Tunisia, from September 21-28, 2000.

This meeting will continue the series of sucessful conferences of Polish experts in thermal imaging, which started two years ago in the Tatra mountains near Zakopane. In addition to the pleasant environment of the mediterranian island Djerba, a Certification Course on "Practical application of thermal imaging in medical diagnosis" will be organized.

For further information contact the organizing Committee at

Pediatric and Nephrology Clinic;
Central Clinical Hospital
Military University, School of Medicine;
Szaserow 128 str,
00-009 Warsaw-60, Poland

Tel/fax + 48 22 6817236

12th International Conference on Thermal Engineering and Thermogrammetry (THERMO)

from the 13th to 15th of June, 2001
in the OSSKI Center (Törley Palace), Budapest XXII (Budafok) Anna u.5.

Objectives

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

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

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

Organisation of the Conference

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

Venue

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

Information

Application Forms should be sent to:

Dr.Imre BENKÖ,

MATE Secretariat, House of Technology,III. 318., H-1372 Budapest, POB. 451., Hungary.
Fax: +361-353-1406 Phone: +361-332-9571.
E-mail: mate@mtesz.hu

For any further information please contact the following address:

Dr.Irme BENKÖ, Technical University of Budapest (BME), Department of Energy
(DoE) H-1111 Budapest, Müegyetem rkp. 7, D.208, Hungary,
office phone. +361-463-2183
BME Fax: +361-463-1110,
DoE Phonelfax: +361-463-3273 or -463-3272.
E-rnail:benko@eta.enrg.bme.hu

5th International Congress of Thermology 2001 in Vienna

The European Association of Thermology will host for the second time the next, 5th International Congress of Thermology. This congress has been held every three years since the first in Washington in 1989. The organisation of this meeting rotates from the AAT(=American Academy of Thermology) to the EAT (=European Association of Thermology) and then the APFT (=Asian Pacific Federation of Thermology). These three continental societies form the International College ofThermology. The presidentship of the ICT changes also every year from one member society to the next. In 2001 the presidentship of the ICD will come back to Europe (former European presidents were Prof. Dr. L.Thibault de Boesinghe, Belgium, Prof. Dr. R.Clark, U.K, and Dr. K.Ammer, Austria). In 1992 the International Congress was held in Ghent, and will be held in Vienna 2001 for the fifth time after Matsumoto in 1995 and 1998 in Ft.Lauderdale.

The Austrian Society of Thermology will organize this meeting on behalf of the EAT and hope, that the conference will be as sucessful as the European Thermology Congress held at the same place in 1997. A distinguished panel of experts will form the Programme Committee which will bring together the leaders in the field from around the world.

Main intention of the meeting is to intensify the cooperation of all users of infrared imaging for the purpose of diagnosis, which is the detection of disease in medicine, but may cover many other fields in technical and industrial applications.

In medical thermology, other aspects than thermo-diagnosis must not be forgotten such as thermo-physiology and heat treatment, both for superficial and deep body tissues. Especially for temperature monitoring of deep body hyperthermia other techniques than infrared such as magnetic resonance imaging are used. Invited speakers will present state of art lectures for this topics.

A small exhibition of latest developments of equipment for thermal imaging and for heat treatment will be shown on site of the conference.

New Thermology Society in Britain

In the Britain the U.K. Thermology Association (UKTA) and the Themology Society of Great Britain (TSGB) have merged in early March. This occured at the conferenece "a World of Thermography", which was held in Bath on March 9-11, 2000 (Abstracts of this meeting appeared in the last issue of this journal)-

UKTA is a professional association dedicated to excellence in all infrared applications, supporting, promoting and expanding infrared imaging and measurement. It was formed to network individuals, organisations and associations in the thermography profession in the UK and the rest of the world. UKTA was created for all those interested in infrared thermography and to support and help unite thermographers. This type of association provides a much needed forum to mould the rapidly developing infrared field and promote standards for thermography amongst users.

The TSGB followed the Anglo-Dutch Thermography Society, after most of the Dutch members ceased to use thermal imaging. The main intention of the TSGB was to function as platform to encourage and expand work in areas of basc medical/physiological thermology and in the clinical application of thermological techniques. Since its foundation in 1991 the TSGB was affiliated to the European Association of Thermology. The former president Prof.R.Clark was also general secretary and later president of the the EAT and in 1992 the second European President of the International College of Thermology.

Members of the TSGB will be represented in UKTA by a group secretary, Dr.JR Harding in the future. All UKTA members are entitled to subscribe to the journal "Thermology international" for a reduced rate, which is ATS 400.-.

The creation of a section for technical/industrial thermography was also suggested for this journal at the Conference in Bath last March. This will be implemented if the submission of papers reporting non medical/biological applications continue and/or other associations of non medical users of infrared imaging will choose the journal as an official publication. To organize such a industrial part in the journal, a section editor has to be installed to guarantee a high scientific quality of this new part of the journal.

"Thermology international" on the internet

The Publisher "Uhlen-Verlag"hosts now (since February 2000) the table of contents of the journal"Thermology international" on their website "www.uhlen.at/thermology international/".

Table of contents since volume 9/1 and the instructions for authors can also be found on this page. It is also linked to the homepage of the German Society of Thermology at "www.thermology.org".

Links to the abstracts of articles from the journal are planned in the near future.

Veranstaltungen (MEETINGS)

26.-27. Mai 2000

Jahrestagung der Deutschen Gesellschaft für Thermologie in Bad Nauheim

Auskunft: Geschäftsstelle der Deutschen Gesellschaft für Thermologie
Rheinstr.5. D-76337 Waldbronn

Tel: +49 7243 66022 Fax:49 7243 6949
E-mail thermo@sauer.de

18.-21. July 2000

QIRT 2000 (Eurotherm Seminar No64) in Reims, France

*Information:*QIRT 2000; Stephan Offermann

UTAP-LEO, Moulin de la Housse, B.P.1039
F-51686 Reims Cedex 2, France

Tel: +33 3 26913413 Fax: + 33 3 26913250
Email: http://www.univ-reims.fr/Qirt_2000

23.-28. July 2000

22nd Annusl International Conference of the IEEE-EMBS combined with **Chicago 2000**, the World Congress of Medical Physics and Biomedical Engineering

Venue: Navier Pier Convention Center,
Chicago II, USA

*Information:*http://www.wc2000.org

5.August 2000

20th Annual Meeting of the German Society of Thermology in Celle

G.Bergmann Award for Thermology 2000
Venue: Sol In Hotel, Celle

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

Tel: +49 35341901160 Fax: +49 35341 90 27 05
E-mail: rheumamike@iname.com

8.-9. September 2000

8th European Congress of Medical Thermology

Venue: Desenzano, Brescia - Italy

Congress President
Dr. Giorgio Dalla Volta
Neurological Department
Istituto di Cura Città di Brescia
Via Gualla 15 - 25100 Brescia (Italy)
Phone: +39/03037101

Organizing Secretariat
Essepi Studio
Via Costalunga 14 - 25123 Brescia (Italy)
25123 Brescia (Italy)

Phone: +39/030382336- Fax: +39/030382653
E-mail: essepist@tin.it

21.-28. September 2000

3rd Congress of the Polish Society of Medical Thermology in Djerba, Tunisia plus

Certification Course
"Practical application of thermal imaging in medical diagnostics"

Information:
Prof.Dr.A.Jung

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

Tel/fax +48 22 6817236

2001

28.-30. April 2001

5thInternational Congress of Medical Thermology combined with the 14th Thermological Symposium of the Ludwig Boltzmann Research Institute for Physical Diagnostics and the Austrian Society of Thermology

Venue: SAS Radisson Palais Hotel, Vienna

Main Theme: Thermology- the science of heat

Topics: Thermo-Physiology,

Body temperature measurement by infra red and other techniques

Diagnostic infrared imaging

Thermo-Therapy

Monitoring (maintenance) by thermometry

Deadline for abstracts: January 19, 2001

ScientificProgramme Committee:

Dr.K.Ammer (president)	(Austria)
Prof.Dr.M.Anbar	(USA)
Prof.Dr.I.Benkö	(Hungary)
Prof.Dr.R.Berz	(Germany)
Dr. A.Camargo	(Brazil)
Dr.G.Dalla Volta	(Italy)
Dr.J.-M.Engel	(Germany)
Prof. Dr. I. Fujimasa	(Japan)
Dr.S.Govindan	(USA)
Dr.J.R.Harding	(UK)
Prof.Dr.B.Jones	(UK)
Prof.Dr.A.Jung	(Poland)
Prof.Dr.Y-S.Kim	(Korea)
Prof.Dr.K.Mabuchi	(Japan)
Dr.H.Mayr	(Austria)
Prof. Dr.R.Purohit	(USA)
Prof.Dr.E.F.J.Ring	(UK)
Dr.O.Rathkolb	(Austria)
Prof.Dr.H.Tauchmannova	(Slovakia)

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Information:
OA.Dr.Kurt Ammer
Ludwig Boltzmann Research Institute for Physical Diagnostics, Hanuschkrankenhaus, Heinrich Collinstr. 30; A-1140 Wien

Tel: +43 1 914 97 01; Fax: +43 1 914 92 64
E-mail: KAmmer1950@aol.com

13.-15. June 2001

12th International Conference on Thermal Engineering and Thermogrammetry (THERMO) in the OSSKI Center (Törley Palace), Budapest XXII (Budafok) Anna u.5.

ConferenceOrganizer:

Branch of Thermal Enineering and Thermogrammetry

Hungarian Society of Thermology at MATE

European Association of Thermology

International Centerfor Heat and Mass Transfer

Deadline for abstracts: 15.10.2000

Information
Dr.Irme BENKÖ, Technical University of Budapest (BME), Department of Energy
(DoE) H-1111 Budapest, Müegyetem rkp. 7. D.208., Hungary,
office phone. +361-463-2183.
BME Fax: +361-463-1110,
DoE Phonelfax: +361-463-3273 or -463-3272.
E-rnail:benko@eta.enrg.bme.hu
or mate@mtesz.hu

8th EUROPEAN CONGRESS OF MEDICAL THERMOLOGY
3rd NATIONAL CONGRESS
OF THE ITALIAN ASSOCIATION OF THERMOLOGY

Desenzano del Garda, 8-9 September 2000

REGISTRATION FORM

Please type or write in block letters

First name ....

Family name ....

Fiscal address ....

Zip Code ....

Town ....

Country ....

Fiscal Code or VAT number ....
(for Italians and Europeans only)

Phone ....

Fax ....

E-Mail ....

Istitution/University/Hospital (complete address) ....

....

....

I send the following registration fee(s):

Teaching Course Itl. ....

Congress: before April 20 ☐ after April 20 ☐ Itl. ....

Total Itl. ....

The payment in favour of Essepi Studio has been made by:

- Bank cheque in favour of Essepi Studio srl.

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I enclose copy of the transfer receipt.

Important Note: the payment of the registration fee made by companies or Institutions must be authorised by the companies/Institutions themselves. The authorisation must be sent in writing to Essepi Studio specifying the name, address and VAT Number (for Italian and European Companies) of the Company/Institution.

Signature .... Date ....

Return to:

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8th EUROPEAN CONGRESS OF MEDICAL THERMOLOGY
3rd NATIONAL CONGRESS
OF THE ITALIAN ASSOCIATION OF THERMOLOGY

Desenzano del Garda, 8-9 September 2000

HOTEL ACCOMMODATION FORM

First name ....

Family name ....

Address ....

ZIP Code ....

Town ....

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Fiscal Code or VAT Number ....
(for Europeans and Italians only)

Phone ....

Fax .... E-mail ....

I would like to make the following reservation:

☐ West Garda Hotel ☐ Hotel Residence Oliveto

n. .... Single room(s) Itl. ....

n. .... Double room(s) single use Itl. ....

n. .... Double room(s) Itl. ....

Reservation fee Itl. 30,000 x n........room(s) Itl. ....

Total Itl. ....

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

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