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Equine Thermography

Reproducibility of Temperature Measurement

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Thermographic Evaluation of the Neurovascularsystem in the Equine

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SUMMARY

Thermography is a non-invasive, non-contact diagnostic technique which measures and displays visual images of infrared radiation emitted by the body surface. Over 25 years of studies in equine with the use of thermography have provided valuable data for clinical evaluation of neurovascular injuries. The cutaneous circulation is under sympathetic vasomotor control. Peripheral nerve injuries and nerve compression can result in vascular changes that can be detected by thermography. The nerve irritation causes vasoconstriction, resulting in decreased temperature gradients by 2 to 3° C and loss of sympathetic tone causes vasodilation and increase in skin surface temperature of 2 to 3° C. Of course, this simple rationale is more complicated with different types of nerve injuries, and the extent and duration of injuries. Therefore, studies were done over an extended period in equine under controlled conditions to provide accurate diagnosis of neurovascular injuries.

Key words: infrared thermography, neurovascular, horses, autonomic nerve system

THERMOGRAPHISCHE BEURTEILUNG DES NEUROVASKULÄREN SYSTEMS BEI PFERDEN

Die Thermographie stellt eine nicht-invasive, berührungsfreie diagnostische Methode dar, mit der die Infrarotstrahlung, die von der Körperoberfläche abgetrahlt wird, gemessen und bildhaft dargestellt werden kann. Seit 25 Jahren haben thermographische Studien bei verschiedenen Tieren wertvolle Daten für die klinische Beurteilung von neurovaskulären Störungen geliefert. Die Hautdurchblutung wird durch das sympathische Nervensystem kontrolliert. Verletzungen peripherer Nerven und Kompression eines Nervs können zu Durchblutungsveränderungen führen, die mit der Thermographie erkannt werden können. Die Nervenirritation bewirkt eine Vasokonstriktion und dadurch bedingte "kühlere Thermogrammme", während der Verlust der sympathischen Aktivität zu einer Vasodilation und "warmen Thermogrammen" führt. Natürlich sind die Verhältnisse bei unterschiedlichen Typen von Nervenschädigungen in Abhängigkeit von Dauer und Ausmass der Störung komplizierter als diese einfache Erklärung. Deshalb wurden eine Reihe von Studien an Pferden durchgeführt, um unter kontrollierten Bedingungen eine genaue Diagnose bei neurovasklären Schäden zu gewährleisten.

Schlüsselwörter: Infrarot-Thermographie, neuro-vasculär, Pferde, autonomes Nervensystem

Thermology international 2004, 14: 89-92

Introduction

Normally, the body temperature is well controlled by its own metabolic state. The skin temperature is normally lower than that of internal tissue and depends not only on the metabolic state of the animal, but also on various factors such as thermal conduction from heat sources within the body, vascular activity within and just beneath the surface, heat losses due to evaporation or to convection by air currents, and exchange of infrared energy to the surrounding environment. Therefore, environmental effects should be minimized by taking thermograms in a room kept at cooler temperature than the body temperature, and free from air drafts (1). The subjects should be equilibrated to room temperature for at least 20 minutes or more prior to performing the studies. If proper precautions are taken, thermograms are truly thermal topograms and the contrasts obtained are largely from the heat conduction to the skin from regions within the body. Careful evaluation of internal and external factors should be done prior to examination and assessment. The purpose of this study is to present some clinical uses of thermography in the diagnosis of neurovascular diseases.

Clinical Studies

Determination of Cervical Sensory-Sympathetic Dermatome in the Horse

In this study, eleven ponies of mixed breed and various ages, ranging in weight from 125-215 kg, were used. Ponies were brought into a temperature controlled room (21 to 26° C) and were allowed to equilibrate for 30 minutes to acclimate to the ambient temperature. The AGEMA 870 infrared thermography unit was used to obtain thermal patterns and temperature gradients in all ponies. Temperature sensitivities between each isotherm were maintained at 0.50 C or 1.0° C for evaluating thermograms.

The pattern of cutaneous distribution of the fourth, fifth, and sixth cervical dermatomes were determined by injecting 5 ml of 0.5% mepivacaine in the dorsal or ventral spinal nerve block was performed at the level of C4, C5, and C6. This spinal block produced two effects. First, blocking the sympathetic portion of the spinal nerves produced increased thermal heat and sweating of the affected areas (Fig 1). The increased thermal patterns were mapped for each dermatome (Fig 2). Second, the area of insensitivity produced by the sensory portion of the block was mapped. The areas of insensitivity were found to correlate with the sympathetic innervation patterns. This study provides evidence that thermographic techniques can be used to map dermatome patterns (2).

Horner's Syndrome

Horner's Syndrome has not been commonly diagnosed because the clinical signs may be extremely subtle and difficult to detect. This condition is due to a paralysis of the cervical sympathetic trunk and causes uneven facial patterns of infrared emissions. In our studies, four adult horses weighing 450 to 500 kg were used for surgical induction of Horner's Syndrome.Unilateral vagosympathetectomies were performed on one side of the neck, thus leaving other side of the face to serve normal control for this study.(3) Facial thermograms were obtained one day prior to surgery and thereafter for several months in all cases. Increases in facial temperatures by 2 to 3° C were observed on the affected side at an early onset of Horner's Syndrome. (Fig 3 and 4) Over a period of 2 to 3 months, readjustment occurred and it was difficult to diagnose Horner's. Injection of 1 mg epinephrine (IV) in the horse resulted in increased thermal patterns and exaggerated sweating response occurred on the affected side. (Fig 5) Whereas injection of acteylpromazine (0.01 mg/kg IV) caused increased heat and thermal patterns on the normal non-neuroctomized side, with little or no effect on the denervated side (Fig 6). Several clinical cases of Horner's were also diagnosed in our clinic using thermography.

Diagnosis of Nerve versus Vascular Impairment to the Limbs

Clinical studies were done to evaluate the effects of a phenothiazine tranquilizer on peripheral thermal changes in horses with either nerve or vascular impairments to the limbs. A series of thermograms were obtained before and after administration of acetylpromazine hydrochloride (0.01 to 0.15 mg/kg). Administration of the tranquilizer caused an increase in isothermal patterns of 2 to 3° C in normal horses. The horse with reduced vascular flow to a limb failed to exhibit a thermal increase relative to the contralateral normal limb (Fig 7 and 8). The leg with the nerve injury was cooler at the initial observation. (Fig 9) In response to acetylpromazine, the ipsilateral limb exhibited a greater thermal increase than in the contralateral normal limb. (Fig 10) This study demonstrated a valuable diagnostic procedure that can be used to differentiate vascular injury from nerve injury. Similar results have been obtained in studies with dogs and other animals suffering from neurovascular injuries.

Conclusion

The value of thermography can only be realized if used properly. All animal species, including humans, have so-called normal thermal patterns and gradients. There are remarkable bilaterally symmetrical patterns of infrared emission n the horse and other animal species studied so far. (1,4,5) The high degree of right-to-left symmetry provides a valuable asset in diagnoses of unilateral problems associated with various clinical conditions. (6,7) Various areas of the body on the same side have a so-called normal gradient temperature (differential) from one area to the next. Therefore, alteration in normal thermal patterns would indicate thermal pathology.

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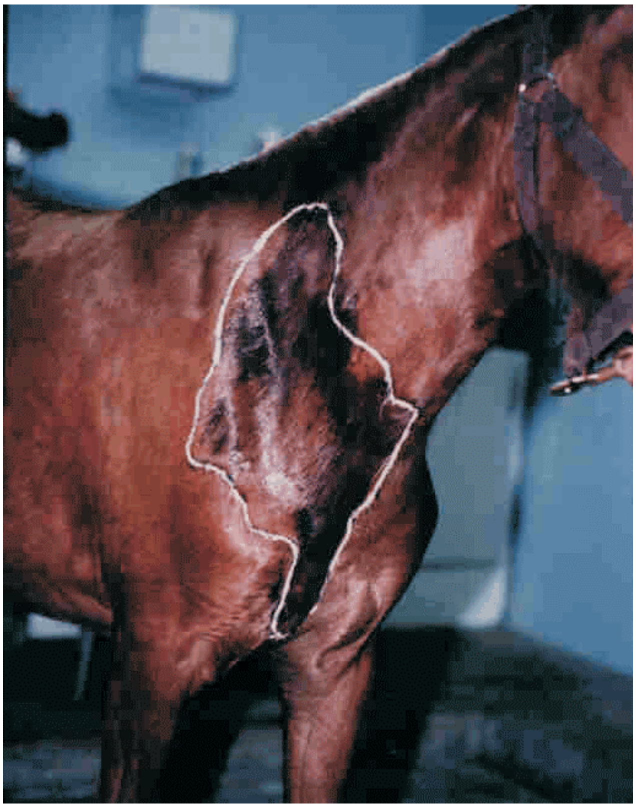

Figure 1
Sixth cervical dermatome in the horse:
area of increased sweating after sympathetic nerve block

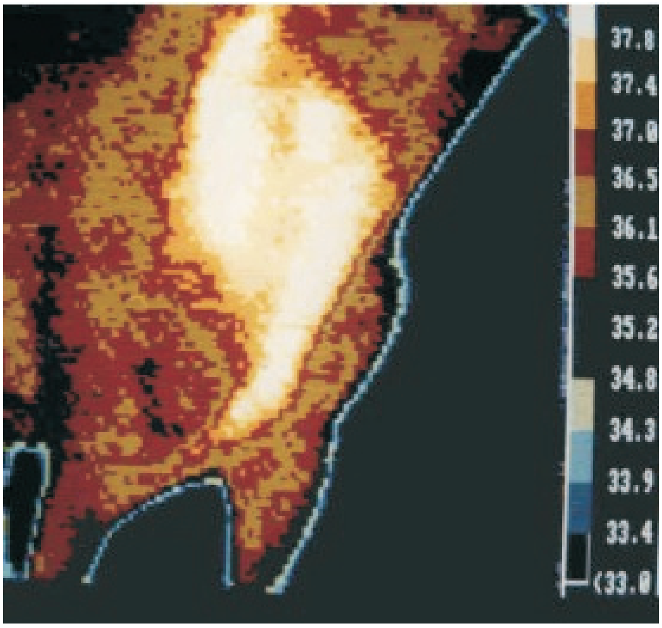

Figure 2;
Correlating thermal image of figure 1

Figure 3
Early case of Horner´s Syndrome temperature difference between affected and unaffected side is aproximately 2°C.

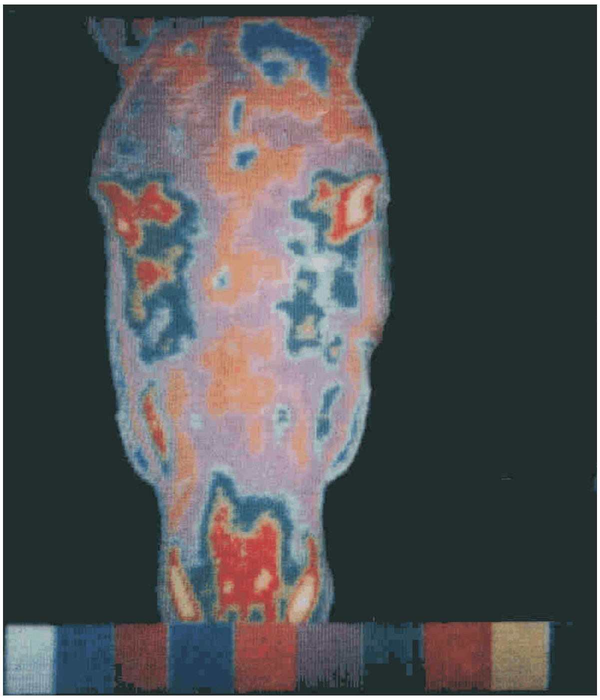

Figure 4
Another early case of Horner´s Syndrome.

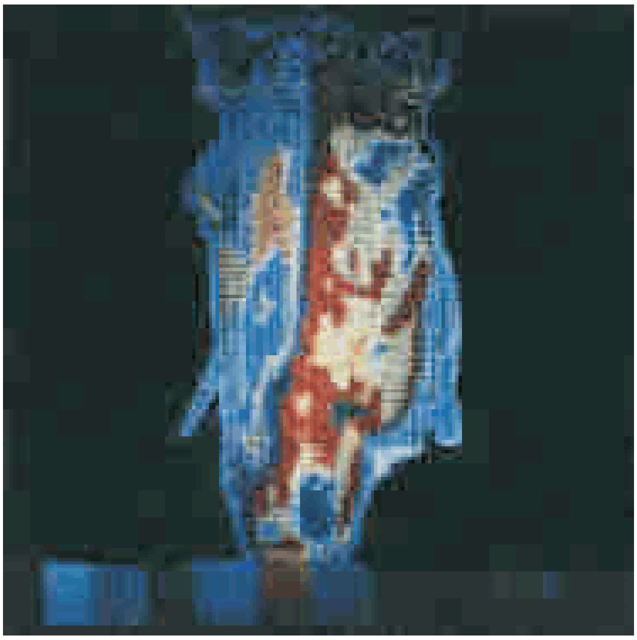

Figure 5
Injection of 1 mg epinephrine (IV) resulted in increased thermal patterns and exaggerated sweating response on the affected sid

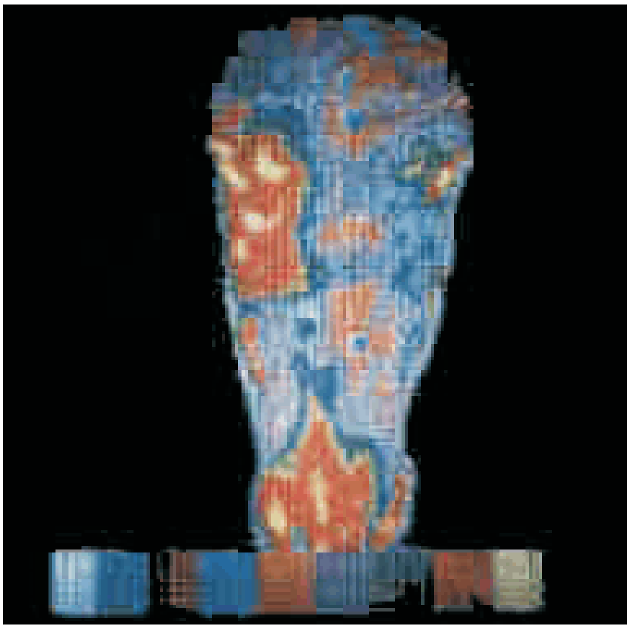

Figure 6
Injection of acteylpromazine (0.01 mg/kg IV) caused increased heat and thermal patterns on the normal non-neuroctomized side, with little or no effect on the denervated side

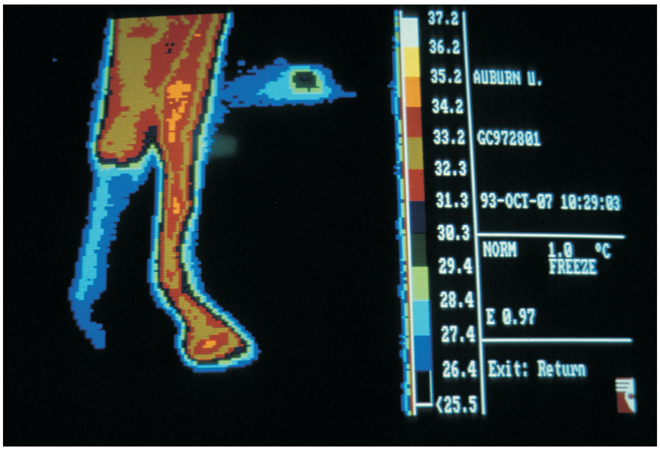

Figure 7
The horse with reduced vascular flow to a limb failed to exhibit a thermal increase relative to the contra-lateral normal limb after administration of acetylpromazine hydrochloride (0.01 to 0.15 mg/kg).

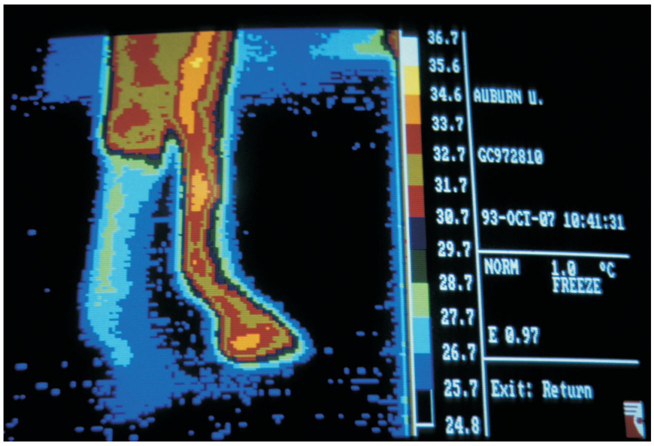

Figure 8
Another example of the condition shown in figure 7

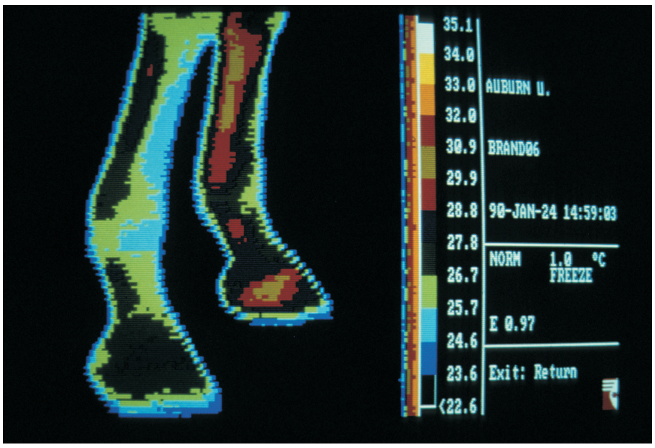

Figure 9
The leg with the nerve injury was cooler at the initial observation.

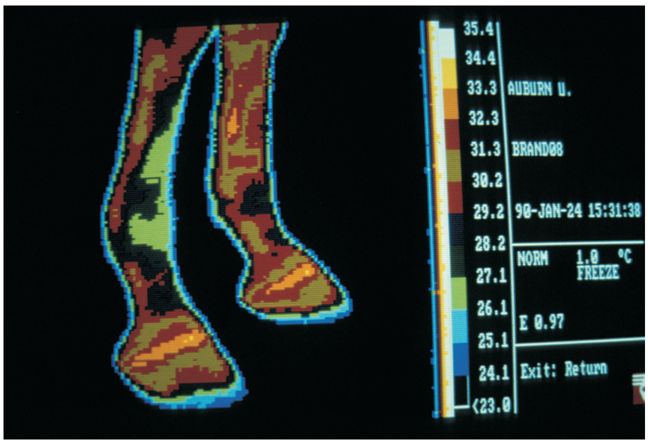

Figure 10
In response to acetylpromazine, the ipsilateral limb exhibited a greater thermal increase than in the contralateral normal limb.

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Cooling effects of Deep Freeze Cold Gel compared to that of an ice pack applied to the skin

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SUMMARY

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

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

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

Key words: ice pack, cooling gel, infrared thermal imaging

VERGLEICH DER KÜHLENDEN WIRKUNG VON "DEEP FREEZE COLD GEL" UND EINER EISPACKUNG AN DER HAUT

In dieser Studie wurde in der Lumbalregion die Wirkung einer zehn minütigen Eispackung mit der 60 Minuten dauernden Anwendung eines kühlenden Gels (Deep Freeze Cold Gel) verglichen, das am folgenden Tag nach der Eispackung angewendet wurde.

Die Probanden befanden sich in Bauchlage auf einer Liege bei einer kontrollierten Raumtemperatur von 22°C. Nach 15 minutiger Akkomodation wurden solange Thermogramme aufgenommen bis keine weitere Temperaturänderung mehr sichtbar war. Die 10x10cm große Eis Packung bzw. das Gel wurde auf Höhe des 4 Lendenwirbels appliziert. Eine Thermographie Kamera Flir SC500 wurde mittels eines Stativs über dem Propanden im vertkaler Kameraposition postioniert. In 3 minutigen Abständen wurden 60 Minuten lange Wärmebilder automatisch mittels der Software CTHERM aufgenommen. Jeder Proband führte während der Untersuchung eine subjektive Beurteilung der Kältetherapie durch. Als Ergebnis zeigte sich, dass obwohl niedrigere Hauttemperaturen (mittlere Temperaturreduktion 7°C) durch die Eisanwendung erzielt wurden, die Hauttemperatur innerhalb von 20 Minuten die Ausgangswerte wieder erreichte. Das Gel, das ebenfalls auf einer Fläche von 10x10 cm in der Lendenregion verteilt worden war, zeigte einen allmählich Temperaturabfall von durchschnittlich 3.5°C. Diese Kühlung blieb fast während der gesamten 60 minütigen Beobachtung nachweisbar, nur nach 50 Minutes zeigte sich in langsamer Temperaturanstieg in Richtung Ausgangswert.

Diese Studie zeigt, dass die quantitativeThermographie ein einfaches und objektives Instrument für die Überprüfung von lokalen Kältetherapien darstellt. Trotzdem muss bemerkt werden, dass der Emissivitätsfaktor von jeder applizierten Substanze bekannt sein muss, da dieser beträchtlich auf das Ergebnis einer berührungsfreien Temperaturmessung Einfluss nehmen kann.

Schlüsselwörter:Eispackung, kühlendes Gel, Infrarot-Thermographie

Thermology international 2004, 14: 93-98

Introduction

The temperature effects of cryotherapy was monitored by means of infrared technology in the past (1). The temperature course of knee joint after treatment with cold packs was shown using thermal imaging (2). Artefacts generated by cold packs were also studied and time of temperature recovery of cold treatment was determined (3).

In a pilot study, it had been shown that the cooling effect of the gel applied to the forearm of volunteers could be successfully monitored by infra-red thermal imaging (4). The gel had been applied for 2, 4, and 8 minutes, and the thermal recovery recorded by thermal imaging. In the following study the objective and subjective cooling effect of Deep Freeze Cold Gel by applying with and without rubbing into the skin was assessed.The temperature decrease from both methods did not reach statistical difference, although the treated area remained cold for longer using the layering application.

Aim and method

The next step in the investigative study was to compare the objective and subjective cooling effects of Deep Freeze Cold Gel with that of a standard ice pack applied to the skin of human volunteers. The area of skin chosen for this study was over the lumbar spine. A region of 10x10cms was used to make a comparison between the cooling effect of a layer of ice of that size and the same area coated with the Deep Freeze Cold Gel. The gel was layered on the skin, as evenly as possible according to the protocol, and this was left for 50 minutes, after which it was removed by wiping clear with paper tissues.

The ice was prepared in a thin plastic box measuring 10x10 cm and 2.5 cm deep. This was wrapped in a plastic sheeting to prevent water from melting ice reaching the skin while in contact. The ice was strapped to the back to maintain firm contact with the skin for 10 minutes (Figure 1). The time of contact chosen for the ice was taken as that used by an average application in domestic use. Physiotherapists may use up to 20 minutes contact but with crushed ice contained in several layers of cotton towelling. To obtain useful results of the re-warming of the skin within one hour, the shorter time of 10 minutes was found to be ideal for the purposes of this study.

Subjects

Six healthy volunteers were recruited, two female and four male for the study. The males had a mean age of 26.5 years (24-30 years) and the females were aged 32 and 26 years.

All were asked to read the prepared information sheet about the study and signed the consent form in the presence of a witness.

Procedure

All measurements were made in a stable air-conditioned laboratory at 22°C, with diffuse airflow to avoid draughts. The subjects were positioned on an examination couch in the prone position. Clothing was removed from the waist to shoulders. Female subjects did not need to remove underwear, but the lumbar and thoracic spine area was exposed for 10-15 minutes until stable temperature readings were obtained.

A Flir SC500 Thermacam infra red imager was positioned over the subject to image the lumbar spine region. The distance between the camera and the skin area under test varied a little depending on body size, the usual distance used in the study was approximately 70 cm.

The thermal image was continually monitored on an image processing system running special software CTHERM. Baseline images were recorded when spot temperatures monitored from four points in the required area of the lumbar region were unchanged for 5 minutes.

After the baseline image, the treatment was applied as described above. Gel was layered on a marked area of skin

Figure 1
Ice block applied to the skin for 10 minutes

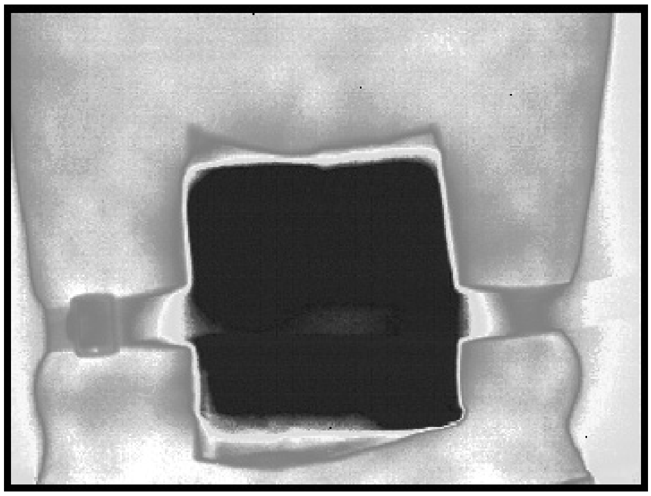


Figure 2
Thermal image of ice strapped to the skin

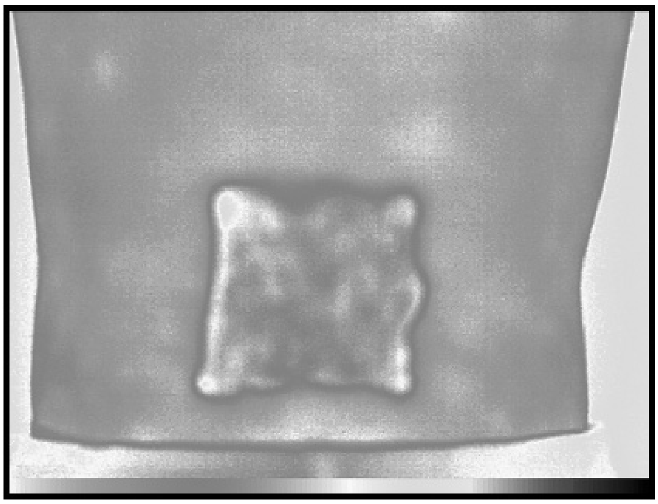


Figure 3
Thermal image of Deep freeze Gel, 1 minute after spreading the gel on the skin

10x10 cm, and ice was applied with a plastic covered container of the same dimensions. Automatic frame grabbing was started at 3 minute intervals for 1 hour. The ice packs were removed at 10 minutes into the experiment.

Throughout the whole experiment the subjects remained on the couch beneath the camera to allow continuous visual monitoring, and regular frame grabbing as described.

The images (approx. 250 in number) were analysed by locating a region of interest (ROI) over the treated area (Figure 2). To take account of any effects from the lateral diffusion of cooling or temperature change at the perimeter of the treated area, the ROI was made slightly larger than the 10x10 target area of skin. The total area of the ROI was between 10 and 15% larger than the cooled area.

Subjective reporting

As reported in the previous study (4), the subjects were asked to respond to four questions indicating their assessment of sensation for each treatment. The choice of temperature changes was indicated at the start of treatment and 10 minutes later. Comfort was indicated at 20 minutes and 60 minutes by a line analogue scale.

Results

Temperatures recorded by quantitative infra red imaging

The median and mean temperature plots for all subjects is shown in Figure 4. In addition the graphic plot for maximum – minimum temperature and standard deviation were calculated to assess the evenness of cooling and or re-warming of the skin. All the graphs show the measurements made from the selected regions of interest.

Median Temperature Change

The subjects when treated with the gel showed that temperature of the gel surface remained reasonably stable throughout the treatment period. Some slight variation was found in the first 10 minutes, probably indicating the effect of the body temperature on the gel itself. There was a slight upward trend in temperature towards the end of the test period. This may indicate a slowing down of the cooling action of the gel on the skin below. Mean temperature results are closely similar to the above.

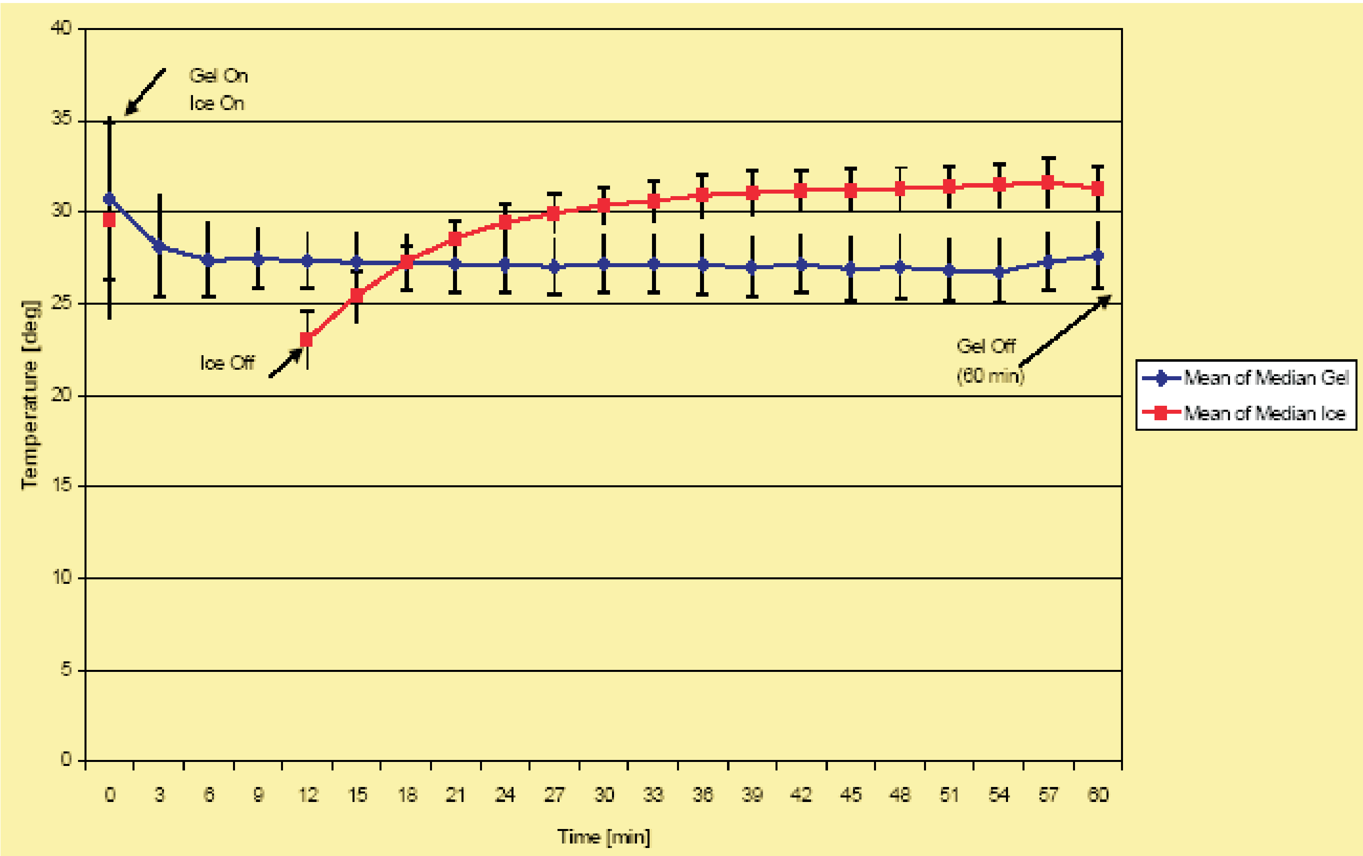
Temperature Difference, maximum to minimum

From these data, the dramatic change caused by the application of ice, and the re-warming of the skin after removal is shown. In the case of gel application, it is clear that the changes in max-min. temperature occur in the first 3 minutes of application, as the gel stabilises, and becomes more even in temperature recorded by the imaging system. The downward trend in temperature difference occurs around 50-55 minutes as shown in the median temperature measurements that increased at this time.

The standard deviation plots show a similar trend to those in the temperature difference expression.

The data for the mean of the median temperatures measured between 9 and 39 minutes (post ice application) were tested by student t test. The result showed a difference between ice and gel application p = 0.056

Figure 4
Mean of Median Temperature resulting from Gel and Ice application, T-Student test value = 0.056

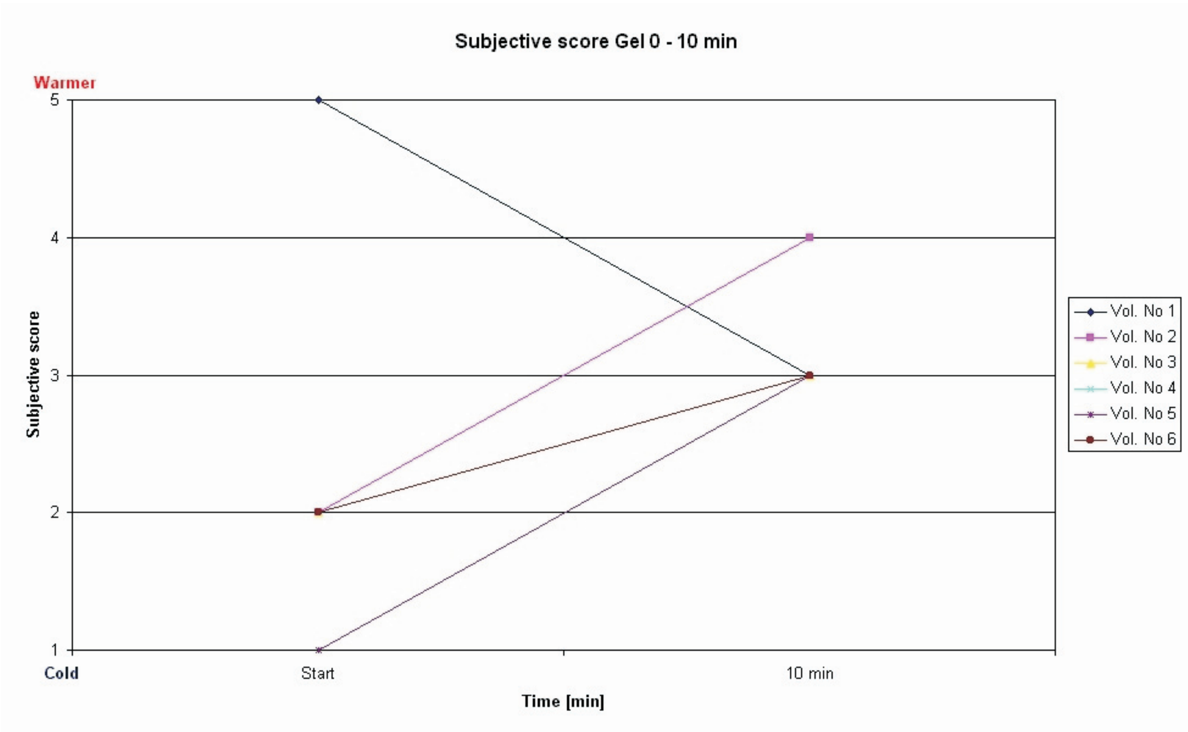


Subjective assessments of both treatments

Two different assessments were recorded for each experiment and on each subject. The first was a series of boxes ranging from number 1 labelled warmer than normal, 2 normal, 3 colder than normal, 4 cold and 5 very cold. The data are plotted for all six subjects and show the change in subjective assessment by the volunteer from the time of initial contact with the treatment to that 10 minutes later.

The second assessment, a line analogue of 10 centimetres ranged from very unpleasant (left) to very pleasant (right). The intercept mark placed by the volunteer at 20 minutes and 60 minutes after treatment were measured from the left (very unpleasant) end. The measurements therefore indicate that zero is very unpleasant, 5.0 is normal and 10 is very pleasant. Therefore the higher the score, the more pleasant the sensation recorded.

These data are shown in Figure 5 for gel and Figure 6 for ice application. The subjective score for gel in Fig. 5 apparently shows only four plots, because three subjects scored at the same level.



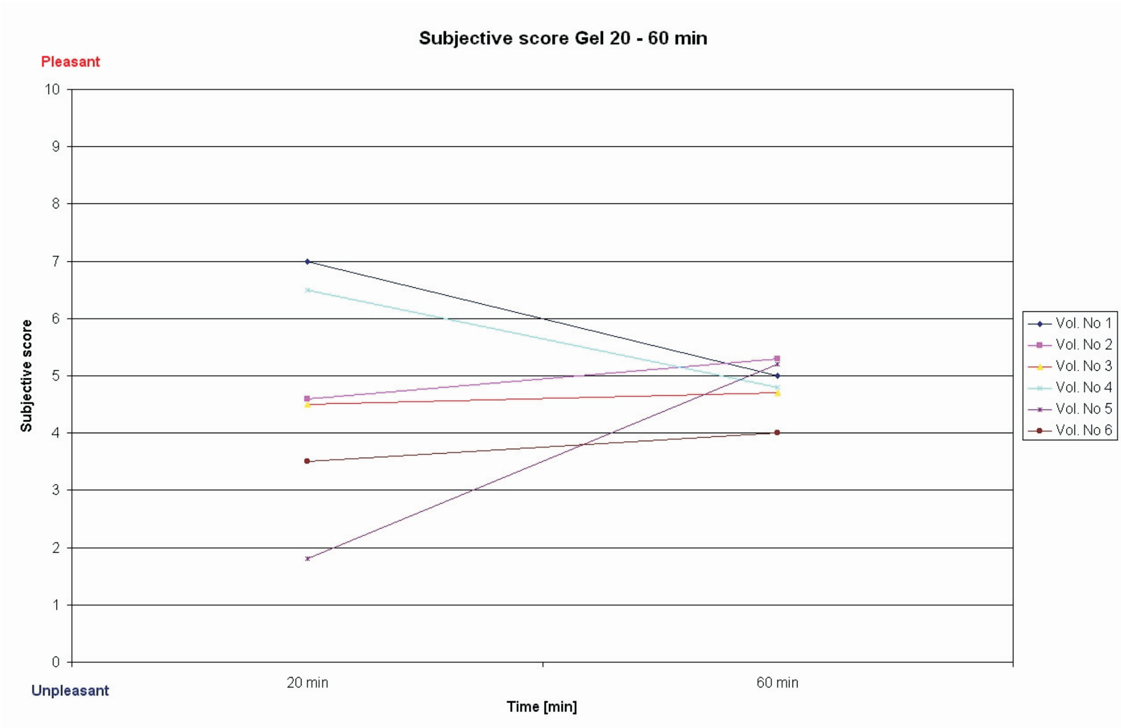


Figure 5
The subjective record made by the 6 subjects at 0, 10 minutes under application of Deep Freeze Cold Gel (top)
Analogue record scores for comfort 20 and 60 minutes later under application of Deep Freeze Cold Gel (bottom)

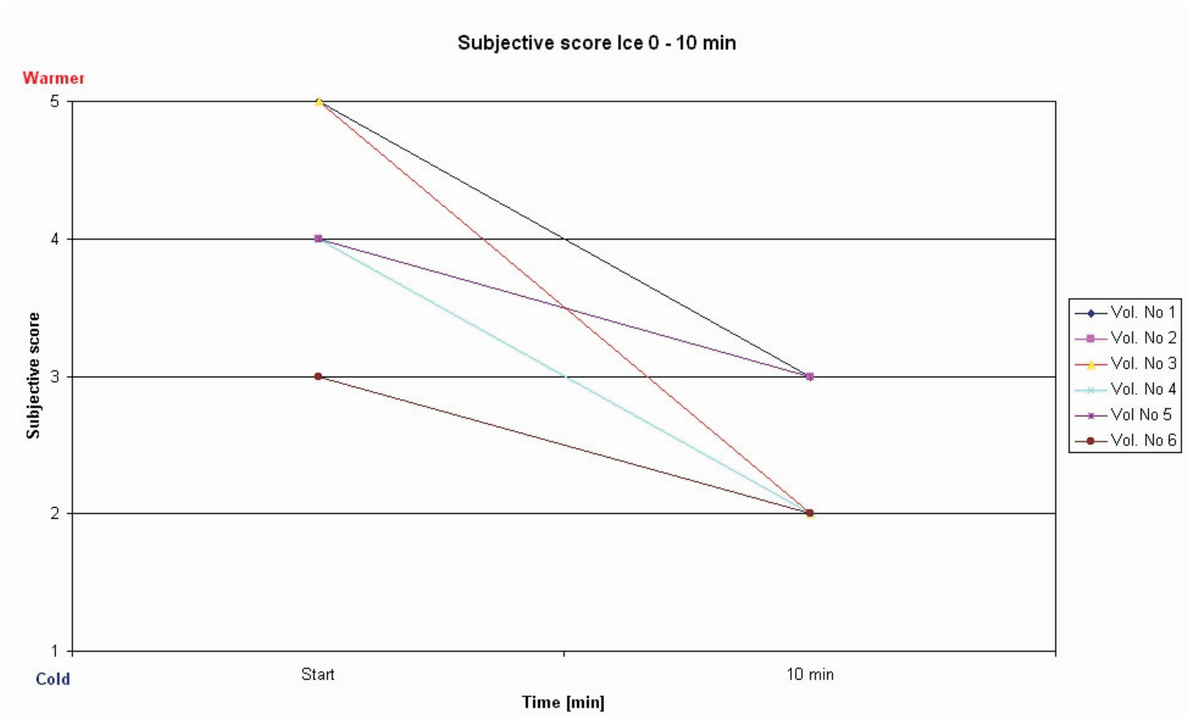
Subject number 6, who volunteered to have a 20 minute ice treatment in addition to that for the protocol scored 3 (colder than normal) initially, 5 (very cold) after 10 minutes. After the ice removal at 10 minutes, the analogue scale showed 3.0 (pleasant) at 20 minutes and 6.1(more pleasant at 60 minutes).

Subjective comments

Both treatments were well tolerated, all subjects volunteered the comment that the gel application was much more pleasant than ice, and seemed to be effective. They were all conscious of the cooling effect of the gel on their skin.

Discussion

There was generally much more reaction to the application of the ice pack than the application of the gel. The initial shock from ice contact which all found unpleasant decreased with time. However, there was a general awareness that the gel was cooling the skin in a milder, but definite



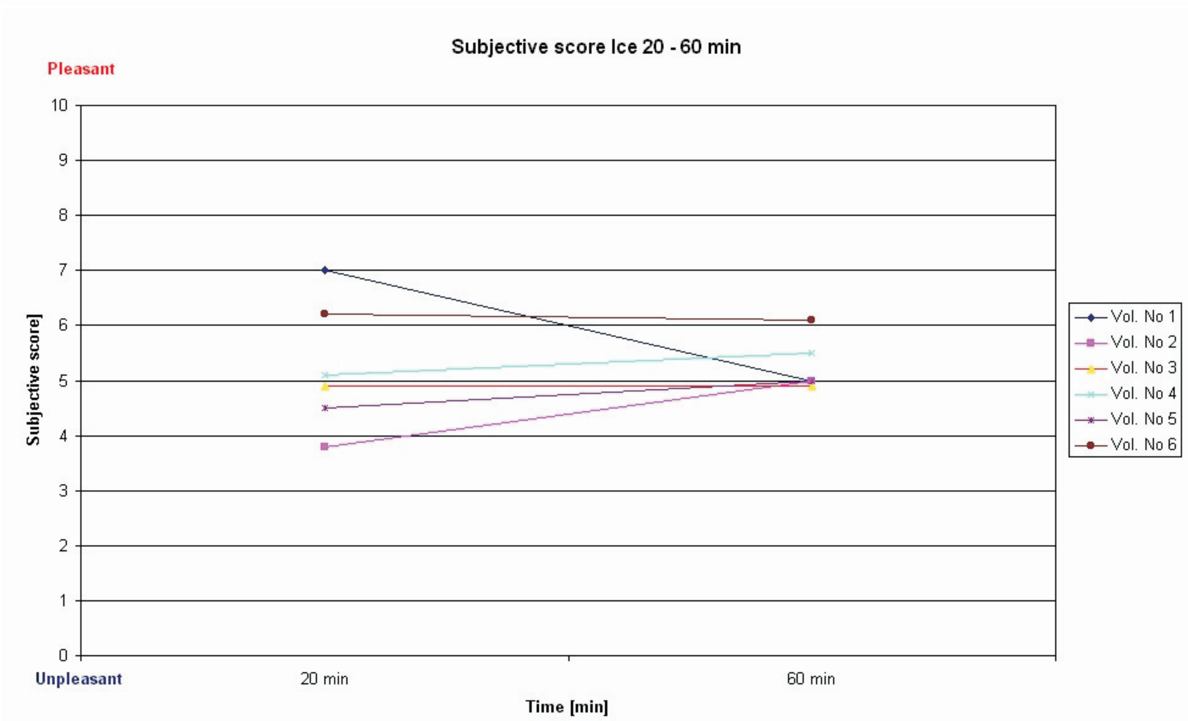


Figure 6
The subjective record made by the 6 subjects at 0, 10 minutes under application of ice (top)
Analogue record scores for comfort 20 and 60 minutes later under application of ice (bottom)

way. One individual reported a sustained cooling effect on his back for one hour after the gel had been removed.

In this laboratory study, the gel was layered onto the skin surface and was not massaged in the way that users would probably prefer to apply it. However, the results do indicate that some gel fraction must be remaining in the skin after wiping off from the surface, hence the longer cooling sensation experienced by the subjects, the one in particular.

In contrast, the cooling of the skin made by the ice pack started to wear off immediately after the ice was removed. Almost all the cooling effects of the ice were gone after 30-40 minutes.

The observations noted from the results of median temperature recordings, suggest that the gel appears to be slowly rising in temperature after approximately 50 minutes. This may be an indication that the cooling action is on the decline, perhaps due to the loss of evaporative action.

The initial application of an ice pack was found by volunteers to be an unpleasant shock to the skin in this study. The progressive cooling effect of the Deep Freeze Cold Gel was therefore preferred to the ice pack. A comparison of the cooling action of the Deep Freeze Cold Gel (Figure 4) versus the natural ice pack applied for 10 minutes indicates that Deep Freeze Cold Gel produces a longer lasting cooling effect by a factor of at least 4 times.

A study using cold packs of different sizes at a temperature of -18°C , has indicated, that the maximal decrease of skin temperature in the lumbar region will may not occur after application of 10 minutes only, independent from the size of the cold pack (5). However, even the short application of ice in this study resulted in a greater decrease of skin temperature than the application of cooling gel. This can be explained by different temperature gradients generated by the investigated methods for cooling. The use of cooling gels for the treatment of soft tissue injuries has recently been investigated in a randomised double-blinded trial (6).

In conclusion, application of Deep Freeze Cold Gel for 50 minutes results in a continuous cooling. The achieved temperature decrease is about a half of that provoked by ice applied for 10 minutes.In general the volunteers indicated that the milder cooling profile of the gel application was more pleasant and much longer lasting than a short application of very cold ice.

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Repeatability of the standard view both dorsal hands. Results from a training course on medical infrared imaging

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SUMMARY

During the 5th Course on Medical Thermal Imaging at the University of Glamorgan, 14 participants twice recorded the dorsal hands of a volunteer with an infrared thermal imager. The repeatability of image capture of the standard view of both dorsal hands has been analyzed. The mean size of the hands, measured in pixel,was about 40000 and varied in repeated image capture in one group by approximately 2300 pixel, and by 600 in the other group. However, there were individual deviations from the mean size of the hands in the range of 5000 to 7600 pixel.

Applying the specified definition for thr regions of interest on one of the images recorded, the mean temperatures of small joints of fingers were measured twice. A remarkable small standard deviation of these repeated measurement was obtained. However, individual errors of measurement up to 2.3°C were seen across the group as a whole.

Using a template for repeated selection of regions of interest resulted in identical temperature values. This however was not the case, if variations in positioning occured during image capture. Reproducibility of both body positioning for image capture and placement of regions of interest are necessary for the credibility of infrared thermal imaging.

Key words: standard view, repeatability, medical infrared imaging, regions of interest

DIE WIEDERHOLBARKEIT DER STANDARDAUFNAHME BEIDE HÄNDE VON DORSAL- ERGBNISSE EINES TRAININGSKURSES ÜBER MEDZINISCHE INFRAROT-THERMOGRAPHIE

Die Wiederholbarkeit der Standard-Aufnahme beide Hände von dorsal wird berichtet. Beim 5. Kurs über Medizinische Thermographie an der Universität von Glamorgan führten 14 Teilnehmer zweimal die Standard-Aufnahme beide Hände von dorsal bei einem Freiwilligen mit einer Thermographie-Kamera durch. Die mittlere Größe der Hände betrug etwa 40000 Pixel und der Größenunterschied bei neuerlicher Aufnahme betrug ungefähr 2300 Pixel in einer Gruppe, und 600 in der anderen Gruppe. Trotzdem wurden individuelle Abweichung von der mittleren Handgröße im Ausmaß von 5000 bis 7600 Pixel beobachtet.

Nach Festlegung von Messarealen auf einer dieser Aufnahmen wurden die mittleren Temperaturen der kleinen Fingergelenke zweimal bestimmt. Dabei wurde eine bemerkenswert kleine Standardabweichung dieser wiederholten Messung erzielt. Jedoch wurden auch hier individuelle Messunterschiede bis zu 2.3°C gesehen.

Die Verwendung einer Vorlage für die wiederholte Festlegung von Messarealen führte zu identischen Temperaturwerten. Das konnte nicht erreicht werden, wenn Abweichungen der Körperposition während der Aufnahme geschahen. Die Reproduzierbarkeit sowohl der Körperposition während der Aufnahme als auch der Platzierung der Messareale sind für die Glaubwürdigkeit der Infrarot-Themographie bedeutsam.

Key words: Standard-Aufnahme, Wiederholbarkeit, medizinische Infrarot-Themographie, Messareale

Thermology international 2004, 14(3): 99-102

Introduction

Standardized positions of the body for image capture is common requirement for quality assurance in many image based diagnostic procedures in medicine. For measurements performed in series of images recorded at different times, the reproducibilty of the body positions within these images is critical. It has also been shown in previous work, that the repeatability of standard views vary according to the body regions investigated (1,2). Variation in body positions may affect the temperature readings from thermal images. This was shown for temperature measurements in thermal images of the same body region recorded at different distances between the object and the camera and thus resulting in fields of view of different size (3, 4). Increasing the distance to the object of interest by 130 cm resulted in a difference of temperature readings by 0,7 °K (5).

In order to improve the repeatability of body positions in standard views for thermal imaging, software tools have recently been developed (6). A practical session in the 5 Short Course on Medical Thermal Imaging at the University of Glamorgan included a study on repeatability, to increase awareness of the importance of body positioning in thermal imaging. This study has demonstrated that reproducibility of technique is an important feature for quality assurance in clinical infrared imaging.

The aim of this lesson for the course participants was to study the difficulty in repeating a thermal image of the standard view both dorsal hands and to observe the variation in positioning that contribute to the reproducibility of temperature readings extracted from thermal images.

Methods

The hands of two volunteers were imaged. After allocation into two groups of 7 subjects, each group member was

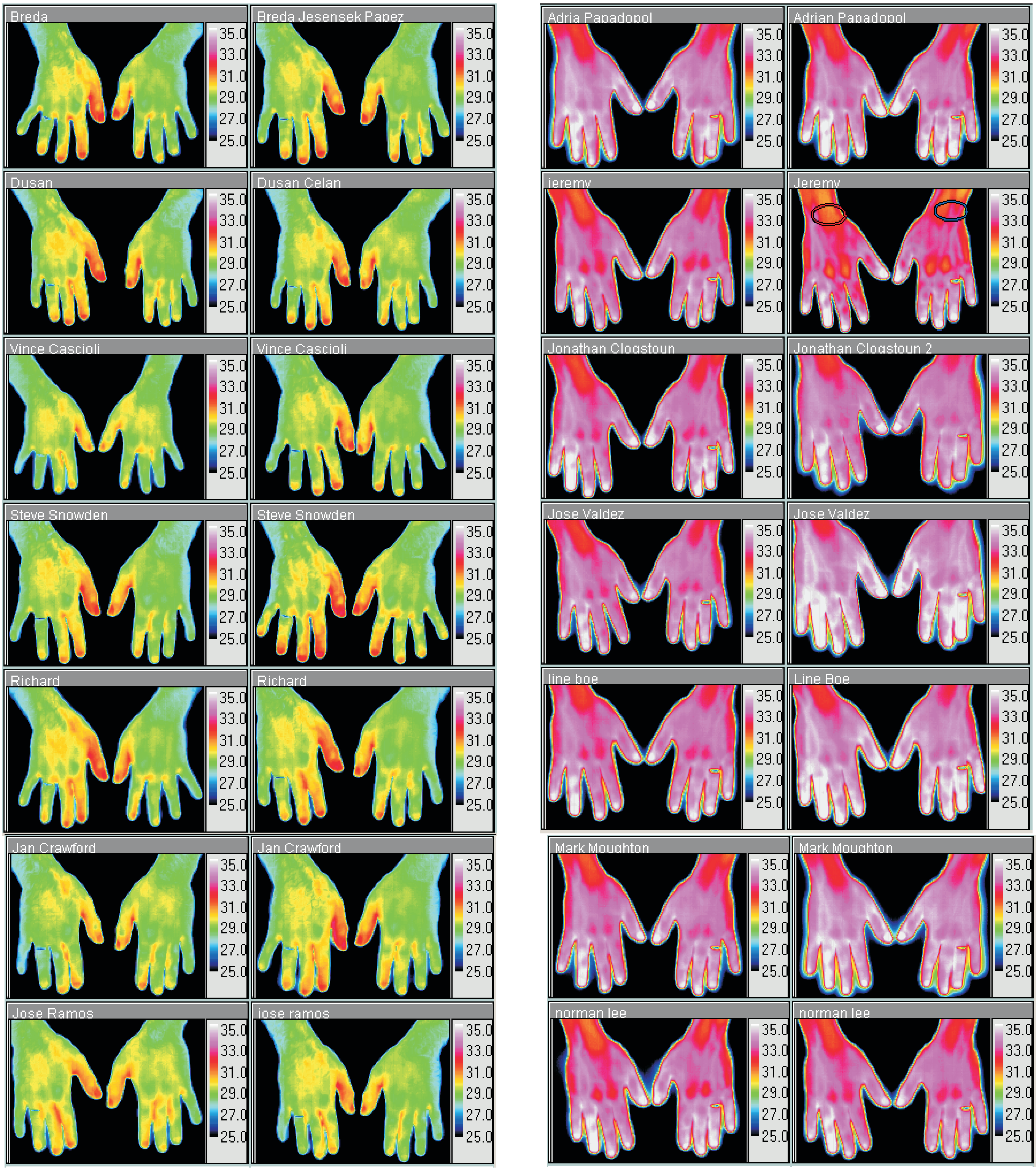

Figure 1
2 series of images recorded from two individuals. 7 participants imaged the hands of 1 individual twice resulting in series A and series B with 14 images each.

instructed to follow the instructions for standard views used in the protocol of the University of Glamorgan. Each then recorded two seperate thermal images of the hands of one volunteer which were then stored on the harddisk of a cn image processing computer.

The position of the hands was evaluated by measuring the number of pixels of each hand using the statistics field tool of the software package Ctherm. Regions of interest in the shape of a polygon were freely defined around each hand, and the polygon was closed on the image of the hand at the joint cleft of the wrist. In the next step, the backgrund tempera- ture was increased to bring the resulting isotherm close to the outline of the hands. The number of pixels inside each region of interest was then recorded.

Data were analysed with the spreadsheet Software Excel 2000 by calculation of mean, standard deviation minimum and maximum values of all measurements. The same analysis was performed for the measuremts of each individual participant. The mean value of all measurements was regarded as being closest to the true value. The individual measurement error was defined by the difference between the mean value of all measurements and the mean value of individual measurements.

Images of the view both dorsal hands were also provided for definition of the regions of interest of small finger joints. 15 regions of interest were twice defined based on the protocol of the University of Glamorgan and the mean temperature in these regions of interest was recorded. The repeated determination of temperature was per- formed in a blind manner as the readers were unable to use any information from the previous measurement. Statistical analysis was performed in the same way as for body positions.

Results

Body position

Figure 1 shows the hand positions as recorded by the two groups. Only slight variations can be observed. As it can be seen in table 1a and 1b, that the mean size of the hands varied in repeated image capture in one group by approximately 2300 pixel, and by 600 in the other group. Most of the individual measurement errors were found within a narrow range.

Regions of interest

8 participants defined regions of interest of all finger joints of the right hand and 4 participants performed the same procedure on the left hand. Smaller variation in temperature readings were found on the left hand than on the right hand side. The individual errors of measurement ranged between -0.26 to 0.17 °C and -2,35 to.+2.35. Table 2 shows mean temperatures ± standard deviation of all regions of interest

Reproducibility of temperature readings from different images of the same subject

One of the participants was aked to repeat his measurements in an unblinded way by using his first definition of regions of interest as template for the second measuring procedure. Using this criterion identical temperature readings were obtained. However, temperature measurements in another image of the same subject, recorded 1 minute after the first image, resulted in the unblinded reader obtaining light variations in temperatur readings.

Table 1a
Size of hands in pixel in series A

	Mean ± standard deviation	Individual error	
		Mean ± standard deviation	Range
1st image	37953 ± 1577	1322 ± 1577	-2792 to 2931
2nd image	40596 ± 3086	-1322 ± 3986	-6583 to 3086

Table 1b
Size of hands in pixel in series B

	Mean ± standard deviation	Individual error	
		Mean ± standard deviation	Range
1st image	39315 ±3812	- 282 ± 3812	-5270 to 7686
2nd image	38750 ± 2632	282 ± 2632	-5979 to 5832

Table 2
Mean temperatures and range of individual errors

Region of interest	Right Hand Side		Left Hand Side	
	Mean ± standard deviation	Range of individual errors	Mean ± standard deviation	Range of individual errors
CMC 1	29.94 ± 0.44	- 1.06 to 0.73	29.10 ± 0.05	- 0.85 to 0.21
MCP 1	30.32 ± 0.42	- 0.28 to 2.32	29.54 ± 0.14	- 0.80 to 0.44
MCP 2	29.75 ± 0.42	- 1.15 to 0.58	29.19 ± 0.18	- 0.77 to 0.40
MCP 3	29.73 ± 0.22	- 0.57 to 0.23	29.77 ± 0.54	-2.35 to 0.15
MCP 4	29.34 ± 0.22	-0.56 to 0.48	29.10 ± 0.11	- 0.06 to 0.27
MCP 5	28.90 ± 0.09	- 0.30 to 0.30	28.72 ± 0.06	-0.20 to 0.20
IP	30.88 ± 0.37	- 0.82 to 0.88	30.09 ± 0.16	-0.70 to .0.62
PIP 2	30.09 ± 0.05	- 0.26 to 0.17	29.22 ± 0.04	- 1.60 to 0.10
PIP 3	29.71 ± 0.06	- 0.14 to 0.25	29.07 ± 0.07	-0.70 to 0.10
PIP 4	29.05 ± 0.15	- 0.75 to 0.63	28.87 ± 0.15	-0.28 to 0.20
PIP 5	28.74 ± 0.24	-0.96 to 0.54	28.23 ± 0.09	- 0.70 to 0.18
DIP 2	30.41 ± 0.28	- 0.49 to 0.61	29.57 ± 0.24	- 0.55 to 0.94
DIP 3	30.05 ± 0.25	- 0. 45 to 0.62	28.87 ± 0.02	-1.55 to 0.08
DIP 4	29.32 ± 0.49	- 1.18 to 2.35	28.55 ± 0.15	-0.28 to 0.20
DIP 5	28.80 ± 0.37	- 1.50 to 0.48	28.16 ± 0.10	-0.60 to 0.28

Discussion

The reproducibility of the positioning for the standard view both dorsal hands was similiar as reported previously (2). However, the instructions for positioning have beem slightly changed since the last evaluation. This was due to the fact, a number of hands were found not to exactly fit the orginal definition for positioning. This change of rules resulted in slightly better reproducibilty of position achieved in this experiment.

Normal values of temperatures of finger joints are not yet been established, However, Engel has published preliminary values for metacarpophalangeal joints (7). Also another study has reported temperature values of finger joints in healthy subjects and in patients suffering from osteoarthritis, inflammatory arthritis, carpal tunnel syn. drome, thoracic outlet syndrome or Raynaud´s phenomenon have bee described (8). In the latter study, the standard deviation of measurements was in all groups of subjects three to six fold of the standard deviation of the repeated measurements in this study. This small variation in temperature readings is likely to be the result of strictly following a standardised procedures for image recording and measurement.

The experiment with an unblinded reader clearly shows that the use of a template for the placement of regions of interest increases the reproducibility of temperature readings. However, such a template cannot overcome measurement errors caused by variations in body positioning.

Individual measurement errors due to variations of the placement of regions of interest can be as large as 2 °C. For prevention of such erroneous measurements, the use of templates or masks for the placement of regions of interest is highly recommended.

In conclusion, the positioning for the standard view of both dorsal hands can be reproduced in a narrow range. As variation in temperature readings from regions of interest from a series of thermal images is also dependent on variation in body position during image capture, the use of special software tools designed to improve reproducibility is necessary.

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31st Annual Meeting of the American Academy of Thermology in Auburn, April 15-18, 2004

I. ABSTRACTS OF ORAL PRESENTATIONS

FROM EVALUATION TO TREATMENT: FIVE NEW DEVELOPMENTS FOR MANAGEMENT OF BREAST CANCER IN THE 21st CENTURY

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In the year 2000 approximately 200,000 women in the United States were diagnosed with invasive or *in situ* breast cancer. Two major breast-cancer-susceptibility genes, BRCA1 and BRCA2, have been identified. Women with mutations in either of these genes have a lifetime risk of breast cancer 60 to 85 percent. Testing for mutations in BRCA1 and BRCA2 is available for predicting breast-cancer risk.

Histological status of axillary lymph nodes is one of the most important prognostic indicators, 80 percent of women who undergo axillary dissection have at least one postoperative complication. Sentinel-node resection has emerged as a safe and predictable alternative to axillary lymph node dissection. Emergence of validated multi-gene assay (OncotypeDX) of breast tumor tissue to predict recurrence in node negative estrogen receptor positive breast cancers will help selecting women in need of adjuvant chemotherapy.

Adjuvant radiotherapy is an essential component of breast conservation therapy. Development of accelerated treatment of breast cancer using interstitial implant to deliver radiation to tumor bed alone over 4 to 5 days seems to produce results equivalent to those achieved with conventional external radiation therapy. The third-generation aromatase inhibitors provide novel approaches to the endocrine treatment of breast cancer. These drugs are effectively challenging tamoxifen, for use in postmenopausal patients with estrogen-receptor–positive cancers, who make up the majority of patients with breast cancer.

BREAST THERMOGRAPHY: HISTORICAL PERSPECTIVES, PAST DILEMMAS, AND FUTURE POSSIBILITIES

Elliott, RL

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Body temperature and its relation to disease goes back to the early days of Hippocrates. The first systematic study of body temperature was made by Carl Wunderlich in Leipzig. Breast Thermography was pioneered by Lawson, and he was one of the first to show the relationship of abnormal breast heat and breast cancer. Later many authors such as Isard, Gros, Gautherie, Amalric, and Stark made tremendous contributions to the evolution of breast thermography. Their work and other events in the development of thermometry will be discussed.

Breast thermography failed to gain support after its experience with the NBDDP and was actually condemned by the American College of Radiology. Thermography was actually considered quackery in many arenas. Many of these dilemmas and reasons for failure will be addressed and others will be challenged.

With even its past problems and lack of acceptance breast thermography has some great future possibilities if used properly and with the appreciation of its limitations. Especially exciting, is the newer technology and instrumentation that is now available. Breast thermography can be now used outside of diagnosis and detection of breast cancer.

Using it in new areas of evaluating prognosis, risk assessment, and treatment response makes it a valuable tool in Breast Cancer Management. All of these possibilities will be discussed in detail and examples will be demonstrated.

PHYSICS AND PHYSIOLOGY OF BREAST THERMOLOGY

Hoekstra, PP III

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Malignant breast disease was among the very first medical diagnostic applications of infrared imaging. However, infrared imaging is not yet a widely applied component of the diagnostic regime for malignant breast disease due to complacency with the current paradigm, the lack of technical standardization and some latent voids in the basic science of infrared imaging. The actual emission of infrared energy is essentially a superficial phenomenon. Unlike the diagnostic applications of infrared imaging for neurological and peripheral vascular disorders that indicate perturbations in cutaneous perfusion; the applications for breast disease necessitates the revelation of metabolic and vascular disorders that may be many centimeters deep.

I conducted an experiment that employed a scanning laser Doppler instrument and a scanning ultrasound Doppler instrument to investigate the source of the vascular-like patterns seen with high-resolution infrared imaging in the breasts of twenty (20) women subjects. Further, I compared the integrity of the infrared vascular-like patterns in the breasts of women diagnosed with malignant breast disease using medium (3-5µm) and long (9-11µm) radiometric infrared cameras.

I conclude that scanning ultrasound Doppler imaging, scanning laser Doppler imaging and infrared imaging each provide distinct and unique data; the infrared imaging of vascular-like patterns in the female breast that is not limited to cutaneous perfusion and may correspond to structures that are many centimeters deep in the breast and that both medium and long wave infrared imaging with high- resolution radiometric cameras provided similar characte- rizations of malignant breast disease.

DEVELOPMENT AND EARLY RESULTS OF A BREAST INFRARED DATABASE (MedATR)

Head JF, Elliott RL, Keyserlingk JR, Gavin RJ Diakides NA

Elliott-Hailey-Head Breast Cancer Research and Treatment Center, Baton Rouge, LA; Ville Marie Multidisciplinary Breast Center, Montreal, Quebec, Canada;

General Dynamics Advanced Information Systems, Dayton, OH;

Advanced Concepts Analysis, Inc., Falls Church, VA

In the spring of 2002, we began to create a database of patient breast infrared images and pertinent clinical information. This database can be accessed by the participants and in the future will be used to test Automatic Target Recognition (ATR) algorithms. By applying the ATR algorithms we hope to better distinguish breast cancer patients from normal patients being screened for breast cancer. The goal is to enter breast infrared images (digital images with radiometric information) and clinical information from 1800 patients. We believe that approximately 10% of the 1800 patients or about 200 patients will have undetected breast cancer at the time of breast infrared imaging. Two centers are evaluating the infrared images twice, once without the patients' clinical information (blind read) and then with the patients' clinical information. Two different methods of analysis (one subjective and the other semi-objective) will be used by the two centers, and this will allow the comparison of results of the two centers for concordance, that is their ability to blindly obtain the same results. After the two readings at both centers, the patients diagnosis (presence or absence of breast cancer) will be compared to the infrared results with and without the clinical results to determine statistical parameters (sensitivity, specificity, false positive rate and false negative rate) for each of the two reading methods. Then ATR algorithms will be applied to the breast infrared images to develop a signature for breast cancer in an attempt to improve the cancer detection ability of breast infrared imaging using a truly objective method.

APPLICATION OF INFRARED BREAST THERMOGRAPHY TO MONITOR BREAST HEALTH IN CLINICAL PRACTICE

Hunt, V.

Co-Founded Medical Thermography International, Inc.; Canada

This presentation will address the key role primary healthcare practitioners have in:

- Educating people about normal breast function in the many stages of life
- ▪ Safely assessing breast physiology using various methods of assessment tools and technologies particularly infrared digital imaging
- ▪ Encompassing and strategically utilizing complementary and alternative modalities to optimize breast function in relationship to the entire person
- ▪ Specific case studies will include all abnormal thermology readings

COMPLEX REGIONAL PAIN SYNDROME: UPDATE

Govindan, S

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To review recent publications on CRPS and its implications on clinical significance of thermography findings in neuropathic pain. Persistent pain syndrome i. e. neuropathic pain is a pathological pain and offers no biological protective role. Such maladaptive pain typically results from damage to the nervous system-the peripheral nerve, the dorsal root ganglia, the dorsal root, or the CNS. It clinically presents as a complex combination of negative symptoms or sensory deficits, such as partial or complete loss of sensation and positives symptoms that include dysaethesia, paraesthesia, pain, and signs of inflammation with vasomotor disturbances and edema. Pain and vasomotor disturbances may be generated by different mechanisms acutely after trauma and in acute CRPS I . Despite clinical similarity, additional changes in the peripheral or central nervous system are required for CRPS. Birklein stated increased systemic CGRP levels in patients with acute CRPS I, suggests neurogenic inflammation as a pathophysiological mechanism contributing to vasodilation, edema and increased sweating. However pain and hyperalgesia in chronic stages were independent of increased neuropeptide concentration. In CRPS I, unilateral inhibition of sympathetic vasoconstrictor neurons led to a warmer affected limb in the acute stage. Secondary changes in neurovascular transmission may lead to a vasoconstriction and cold skin in Chronic CRPS I, whereas sympathetic activity is still depressed. Mean density of alpha I adrenoceptors was significantly higher in the hyperalgic skin of the CRPS I patients, than in the skin of normal individuals. The individual vascular abnormalities are dynamic and depend critically on activity in sympathetic vasoconstrictor neurons. There is evidence of inhibition of cutaneous sympathetic vasoconstrictor neurons that is characterized clinically by a warmer affected limb in the initial stage of the disease. In chronic CRPS, sympathetic vasoconstrictor neurons are still inhibited but the temperature of the skin changes gradually to the colder values caused by secondary changes of the neurovascular transmission. Birklein (2001) documented differences between acute limb trauma and CRPS I and reported sympathetic failure, as indicated by impairment of sympathetic vasoconstrictor reflexes and hyperhidrosis was found exclusively in CRPS I patients. The coincidence of inhibition of vasoconstriction and enhancement of sudomotor function implies central disturbances of thermoregulation in CRPS I. Mannihofner et al (2003) recently published a study that showed reorganization of the S1 cortex contralateral to the CRPS affected side. The reorganization appeared to be linked to complaints of neuropathic pain. Pain itself may be associated with reorganization of the primary somatosensory cortex for certain body regions.

The maximal skin temperature differences that occurs during the thermoregulatory cycle can be used as a descriptive measure of vascular dysregulation and is a novel and reliable diagnostic measure to distinguish CRPS I from other extremity pain syndromes. Understanding the central nervous system involvement in CRPS I, will help thermologists to clinically correlate the thermography findings in the differential diagnosis, treatment and rehabilitation of patients with Chronic Neuropathic Pain.

STRESS INFRARED TELETHERMOGRAPHY IS USEFUL IN THE DIAGNOSES OF COMPLEX REGIONAL PAIN SYNDROME, TYPE I (FORMERLY REFLEX SYMPATHETIC DYSTROPHY)

Gulevich SJ; Conwell TD; Lane J; Lockwood B; Schwettmann RS; Rosenberg N; Goldman LB;

Colorado Neurological Institute and Colorado Infrared Imaging Center

Objective: To assess the sensitivity, specificity, and predictive value (PV) of stress infrared telethermography (IRT) in Complex Regional Pain Syndrome, Type I (CRPS-I).

Methods: One hundred eighty-five consecutive patients (47 men, 138 women) with 205 pairs of chronically painful limbs (upper, lower, or both) were examined by pain specialists in neurology, physiatry, and anesthesia, who then reached a consensus diagnosis. A clinical diagnosis of CRPS-I required at least two of the following observations: burning pain, vasomotor changes, diaphoresis, trophic changes, and allodynia. Patients with only one criterion were classified as possible CRPS-I; those with none were judged not to have CRPS-I. Patients and 24 asymptomatic control subjects underwent stress IRT, which was considered positive for CRPS-I if it showed three of the following: quantitative thermal emission of > 1 °C, abnormal distal thermal gradient patterns, presence of a "thermal marker," and abnormal response to functional cold water autonomic stress testing.

Results: By clinical criteria, CRPS-I was diagnosed in 73 pairs of limbs; not CRPS-I was diagnosed in 70; and 62 pairs had possible CRPS-I. Excluding possible CRPS-I cases, there were 5 false-negative stress IRTs (sensitivity 93%) and 7 false-positive results (specificity 89%). Based on estimated 50% prior probability for our population, the positive PV is 90% and the negative PV 94%. None of the control subjects exhibited thermographic evidence of CRPS.

Conclusion: Stress IRT is a sensitive and specific indicator of CRPS-I.

Reference

The Clinical Journal of Pain 13:50-59, 1997

CHRONIC PAIN SYNDROMES, ROLE OF CENTRAL SENSITIZATION

Govindan S.

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Chronic pain syndromes include migraine and chronic regional pain syndrome/ reflex sympathetic dystrophy. Both have:

1) Neuropathic maladaptive pain associated with allodynia and hyperpathia,

2) Signs of inflammation with vasomotor disturbances and edema, 3) Neuropeptide changes, 4) A-V O difference or tissue hypoxia, 5) Role of AVAs in altering flow independent of metabolism 6) Central sensitization i.e., involvement of brainstem, thalamus and or cerebral cortex and 7) Involvement of trigeminovascular system.

In migraine Weiller published involvement of brainstem nuclei regulating antinociception and vascular control and Burstein addressed central sensitization and the involvement of first, second and third order of neurons i.e., trigeminal ganglion, trigeminal neurons in the brainstem and thalamus. Brain imaging studies in humans have shown activation of multiple cortical areas by noxious stimuli. Recent brain imaging studies have indicated that brain areas activated by acute experimental pain partly overlap with areas processing innocuous tactile stimuli. Alterations in tactile sensitivity are common in patients with chronic pain. Juottonen reported altered central sensorimotor processing in patients with CRPS and that chronic pain may alter central tactile and motor processing. In addition to cortical mechanisms, changes at the spinal cord and thalamic levels affect the amplitudes of the cortical responses. Chronic pain has been shown to affect transmission of impulses at the spinal cord level by sensitizing spinal dorsal horn neurons to input from primary afferent fibers thus leading to enhanced cortical SI responses. Flor and colleagues presented data to indicate that chronic back pain is accompanied by cortical reorganization and may serve an important function in the persistence of the pain experience. In recent years CRPS/RSD investigators have suggested that cortical reorganization develops in response to pain. Lesions of the afferent nervous system may lead to cortical reorganization. Cortical reorganization positively correlated with the occurrence of pain in amputees and in cases of non-amputee pain. On the other hand, prolonged non-painful afferent stimulation during physical strain, e.g., in string players or Braille readers led to an extension of the cortical representation of the hand in to adjacent zones. Soros studied functional reorganization of the human primary somatosensory cortex after acute pain using magnetoencephalography and summarized results of somatosensory plasticity after de-afferentation and training in animals and humans and after chronic phantom pain in human amputees and emphasized on significance of pain-induced plasticity. Support for central mechanisms being involved in the pathogenesis also comes from the recent publication of increased frequency of mechanical allodynia and movement disorders in CRPS patients with hemisensory impairment or sensory deficits in the upper quadrant. Thermologists should incorporate these data when they correlate the clinical significance of their findings in patients with neuropathic pain.

THERMOLOGY IN BACK PAIN

Shafer D.E., Farley J.D., Shafer S.T.

The purpose of this presentation is to describe how we utilize The Flexitherm Mark II Thermograph as a diagnostic tool in the treatment of back pain. In my Orthopedic Practice we treat many laborers injured in coal mines and on the railroad. A thermograph adds diagnostic information helpful in treating injured backs. Response to treatment can be evaluated. Also, most patients have standard X-rays, MRIs, or CT scans which direct their care to surgery, therapy, and medicine. A thermograph is just as useful as these diagnostic tools. When these tools are normal, a thermograph can yield further information, and point to change the treatments of back pain. In this series, several ruptured discs were identified, trigger points and sacroileitis, strain, and sprains were identified using the Flexitherm Mark II. Thermology aids in the diagnostics of back pain in injured laborers.

NEW ROLES OF THERMAL IMAGING (TI) IN MONITORING PAIN MANAGEMENT

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Founding Director of the American Pain Society.
Founding Director of the American Association of Pain Management.

Significant progress in clinical experience; interpretation and clinical advances since Dr. Raymond Lawson introduced the human application of thermal imaging in 1954 has occurred. Passing through the descriptive phase it has now entered the interventional providing a clear understanding for the diagnosis and therapy of pain management. Based on our laboratory experience, three concepts will be presented with supporting data.

STUDY 1 – Cranial Electrical Stimulation (CES) and FDA approved noninvasive pain treatment modality monitored by thermal imaging (TI) as demonstrated in this elective study of posttraumatic cervical/dorsal myoligamentous strain.

STUDY 2 – Sphenopalatine-ganglion blockade by transmucosal 1% Lidocaine block applied unilaterally or bilaterally de monstrates the complex autonomic and somatic nerve interaction in cervical/dorsal myofascial regional pain syndromes monitored by TI Type III pain syndromes.

STUDY 3 – Five-year retrospective study shows stimulation of neuroaxis by biocompatible on demand electrical systems, in 49 patients representing an estimated 48,000 hours of stimulation, as an effective alternate to ablative surgery in the management of chronic organic regional low back pain syndromes. Clinical criteria of improved sense of well-being; reduction of drug intake; and increase in activities of daily living were employed to show that 60% of selected patients reported improvement in which stimulation-induced hypoalgesia (SIH) was present. No surgical mortality in the series was reported. Complications of electrode migration 14%; rejection syndrome 6%; infection 6%; and unknown causes for failure 8%. Granulation tissue, apparently stimulated by electrical energy suggested application in the healing process needs further study. Existence of variable responses to neural adaptation is suggestive in some patients exhibited by the drop in the stimulation efficacy (SE) after long-term stimulation of fully implantable syndromes. The challenge by the antagonist, Naloxone, produced variable responses in cooperative patients. This was important because it demonstrated at least a partial opiod modulated dependent neurosystem effecting Type III chronic regional pain syndromes. Chronic regional pain Type III syndromes are mediated principally over small, slow, firing unmyelinated C-fibers, especially as seen in RSDS/chronic regional pain syndromes following the diagnostic guidelines as recently described by the Federal Register of October 2002. Thermal imaging presents new data acquisition by the demonstration of the Thermatome and radicular pain patterns that cannot be demonstrated by the limitations of the electromyogram, which is not able to demonstrate small, unmyelinated C-fiber activity.

Conclusion – TELE-Thermal Imaging is a valuable addition to pain management, diagnosis, and therapy tests that provide an objective documentation in regional pain syndromes because it provides clinical neurophysiological data not provided by structural imaging tests such as the MRI or CAT scan. The integration of medical data compliments each modality, only however, when thermal imaging is performed according to the guidelines of the American Academy of Thermology.

DEVELOPMENTS IN IR THERMOGRAPHIC TECHNOLOGY

Styron, JS

FLIR District Sales Manager, Atlanta, Georgia

Present new technology in IR thermography to show advancements in hardware, reporting software, research software, and database software. These new advancements yield improvements in ease of use, cost reduction, and increased image quality. The presentation will be focused on live product demonstrations and Power Point presentations. The Power Point will show the history of and developments in IR technology with examples from human and animal research.

INTRODUCTION TO THE ACII AND ACBII

Vlasuk SL

Secretary-Treasurer, American Chiropractic College of Infrared Imaging, Bellevue, Washington, 98004-4620, USA

Purpose: To introduce and define the infrared imaging certification board and specialty organization within the chiropractic profession.

Methods: Identification of organizational structure, educational syllabus, certification process, technical protocols, policies, and continuing education standards of the *American Chiropractic College of Infrared Imaging*, and its certifying agency, the *American Chiropractic Board of Infrared Imaging*.

Results: The stringent certification process and political organization of the American Chiropractic College and Board of Infrared Imaging have resulted in a highly limited elite cadre of infrared imaging specialists within the chiropractic profession.

Conclusion: ACII members are prepared by education, certification, and organizational constraints to contribute in an interprofessional setting toward the responsible utilization and advancement of infrared imaging.

THE VALIDITY OF THE AUTONOMIC STRESS TEST IN BREAST THERMOGRAPHY PROCEDURES

Amalu WC (Presented by TDConwell)

Redwood City, California, 94063, USA

The validity of the autonomic nervous system cold challenge for use in screening breast thermography will be reviewed. A review of the literature will be discussed, along with reasoning for the choice of the cold stress method used. Images of patients will be presented demonstrating positive and negative responses to the challenge. Breast thermograms of patients with normal parenchyma, along with patients with known carcinoma of the breast will be presented. A summary will question the validity of the cold challenge in that a negative response does not rule out the possibility of neoplasm, nor does a positive response guarantee its existence.

THE AUTONOMIC CHALLENGE AND BREAST THERMOLOGY

Philip P. Hoekstra, III, PhD

Thermology markedly differs from every other diagnostic imaging technique as it is functionally based. Similar to other physiologic procedures, such as the electrocardiogram, thermology can achieve a higher order diagnostic power when the response to an adaptive challenge is used to reveal related pathophysiology. Nitric oxide vasodilation and neo-angiogenic blood vessels are reliably associated with malignant breast disease and can be indicated by the use of different forms of provocative challenges with high-resolution radiometric thermology, even when many centimeters deep.

I conducted an experiment in which I evaluated the response to different forms of provocative challenges in the evaluation of breast thermology as a diagnostic method for malignant breast disease. Some forms of these provocative challenges produced complex physiologic responses while others proved more simple, predictable and reliable.

CAN INFRARED IMAGING DETECT EARLY ANGIOGENIC/METABOLIC ACTIVITY IN THE BREAST

Alexandra Boyd, MBBS, MScCTM(Lon) FRACGP

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It is well known that angiogenesis is associated with tumor development in the beast in the majority of cases. Angiogenesis vessels by nature are not the same as normal blood vessels, nor do they respond to sympathetic stimuli to constrict. Therefore, when a cold stress test (which usually consists of putting one hand in cold water at 11 degrees for 1-2 minutes) is applied, the sympathetic system sends a message to vasoconstrict blood vessels. If these vessels that can respond are adjacent to angiogenic vessels that cannot vasoconstrict, then it is possible that the angiogenic vessels will increase in caliber and temperature. This paradoxical warming (metabolic contrast indicator) may show as an actual increase in temperature at the site. Capture of images taken during the cold stress period may show small increases in temperature. These could be considered due to presence of angiogenic vessels. This paper will look in detail at the images of several patients taken during the cold stress period. Reviewing images only after cold stress testing has been completed may lead to these early signs being missed.

THE INTEGRATION OF THERMOGRAPHY INTO AN AMBULATORY EQUINE PRACTICE

Marcella KL

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The purpose of this presentation is to show how thermal imaging can be incorporated into a traditional mobile equine practice. It is generally thought that diagnostic modalities such as nuclear scintigraphy, magnetic resonance imaging and thermography are usually found only at referral clinics and that these techniques are beyond the reach of the average practitioner. While there are specific equipment requirements that make many upper-level diagnostic tools impractical for field use, thermography is uniquely suited to use in day-to-day equine practice. Advances in unit design have produced lightweight, portable cameras that produce exceptional images. These images are easily recognized and understood by clients and current methods of data manipulation allow thermal scans to be archived for later comparison.

This presentation will detail how thermography is incorporated into traditional lameness diagnosis. Case examples will be provided showing how thermography aids the practitioner in uncovering a primary lameness and in separating that problem from compensatory concerns. Examples will be given illustrating how thermography generally confirms a lameness location but usually suggests use of another diagnostic modality for confirmation of the problem. This use of thermography, followed by radiology, ultrasound or scintigraphy for diagnostic confirmation, is good medicine and it can also be good business for the practitioner who is uncertain as to whether thermography can be economically justified in private practice. Because most viewers easily understand thermography scans, client acceptance is high, as is client compliance when scans indicate rest, or physical therapy or other treatments. Rescanning with comparison to prior images allows the client to visualize improvement or worsening of a particular condition and this visualization seems to strengthen understanding and appreciation for the practitioner's diagnosis and treatment plan.

Additional examples of thermography use in private practice will include evaluation of saddle fit, and monitoring of foot and leg casts and wraps. Use of thermography at Endurance Competitions will also be presented, as this modality is exceptionally useful in evaluating problems encountered in horses going 50 to 100 miles in generally extreme conditions. Many of these competitions are held in remote areas without access to electricity making thermography the diagnostic modality of choice.

RECOGNITION OF DERMAL PATTERNS BY THERMOGRAPHY AS A DIAGNOSTIC TOOL IN VETERINARY MEDICINE

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In performing thermographic examinations, one has to be aware that the surface of skin temperature markedly differs in the various regions. Recognition of normal thermal patterns and temperature gradients are the important considerations for utilizing thermography as a diagnostic tool.

Certain chronic and acute painful conditions associated with peripheral neurovascular and neuromuscular injuries are easy to confuse with the injuries associated with cervical, thoracic, and lumbar-sacral areas. Similarly, inflammatory conditions such as osteoarthritis, tendonitis, and other associated conditions may also be confused with other neurovascular condition. Thus, studies were done over the last 25 years at Auburn University to differentiate the patterns of cutaneous distribution of cervical, thoracic, and lumbosacral dermatomes in horses.Infrared thermography was used to map the sensory-sympathetic dermatome in horses. The dorsal or ventral spinal nerve(s) were blocked with 0.5% of mepevacine as a local anesthetic.The sensory sympathetic spinal nerve block produced two effects. First, blocking the sympathetic portion of the spinal nerve caused increased thermal patterns and produced sweating of the affected areas. Second, the areas of insensitivity produced by the sensory portion of the block were mapped and compared with the thermal patterns. The areas of insensitivity were found to correlate with the sympathetic innervations.

Thermography was also used to determine chronic vs acute nerve injuries in associated regions from the head (Horner's Syndrome) to the epidural areas. In general, chronic injuries associated with nerve comparison provided cooler thermal patterns, whereas acute nerve injuries (associated with neurectomies) provided warmer thermal patterns. Neurectomies of log standing (5 weeks or more) reverted back to normal or cooler thermograms. In such cases, a differential diagnoses of various neurovascular conditions can be made from thermograms obtained before/after challenge testing (before/after exercise, before/after cooling or heating, and after administration of a tranquilizer (acetylpromazine).

THERMOGRAPHIC ASSESSMENT OF RACING THOROUGHBREDS

Turner TA

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Lameness is a significant cause of wastage in racehorses. Research has indicated that thermography can predict joint and tendon problems two weeks before they become clinically apparent. However, this hypothesis has not been tested in a clinical setting. The purpose of this study was to determine the usefulness of thermography to assess Thoroughbred racehorses in training. Specific objectives were to determine if thermography could predict injuries before they became clinically apparent, to determine how well thermography correlated with trainer's concerns, and to determine how well thermography correlated with the treating veterinarian's findings. In addition, we wanted to ascertain the acceptability of thermography in the racetrack environment, and to develop guidelines for effective future use in the racing industry.

Thermography was very useful in the assessment of racing Thoroughbreds for injuries. Thermography had an excellent correlation between trainer perceived problems and veterinarian diagnoses and showed increases in heat in most cases two weeks before the region became a problem clinically. When thermography is used to scan Thoroughbred racehorses on a routine basis, injuries can be identified at an early stage before progressing in a clinical severity.

TESTICULAR THERMOGRAPHY AS A DIAGNOSTIC AND PROGNOSTIC TOOL IN EVALUATION OF TESTICULAR INJURY IN STALLIONS

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Scrotal thermography has been used in the bull, ram, human, buck, stallion, llama, and dog to study scrotal thermoregulation. In the normal scrotum, several characteristics extend across species. There is symmetry between the patterns of the left and right testicle and there is a decreasing temperature gradient from the base to the apex of the scrotum. Stallions and humans have a temperature gradient of 3 degrees C to 4 degrees C, while bucks and bulls have a 4 degree C to 6 degree C thermal gradient. This gradient is demonstrated by concentric bands from the base to the apex of the scrotum, with the cooler temperatures near the apex. This correlates to the vascular countercurrent heat exchange mechanism of the testicle.

A six-year old Quarter horse stallion was presented for acute idiopathic testicular degeneration. Declining sperm quality was noted during the 14 collections and evaluations performed during the previous month. Physical examination of the reproductive tract showed normal accessory sex glands, the left spermatic cord palpated approximately 0.5cm larger than the right, and the testicles were less turgid than normal. Ultrasonography showed a peritesticular fluid accumulation and decreased echogenicity in the left testicle. Semen collection at this time yielded only < 10% morphologically normal spermatozoa, and < 10% progressive motility. Scrotal thermography showed slightly elevated temperatures in relation to the medial thigh, and an elevated gradient in the left testicle as compared to the right. The stallion was rested for three weeks, semen evaluation at this time was very poor, progressive motility was less than 1%, there were only 15% morphologically normal spermatozoa in the sample. Subsequent evaluation suggested improvement in thermal gradients and patterns. Semen morphology indicated increased motility.

A second Tennessee Walking horse stallion, eight years old, was presented for scrotal swelling of three days duration. Ultrasonography revealed a suspected hematocele with an organizing clot. The majority of the swelling was located on the right side of the scrotum. Exploratory surgery was performed to reveal that the testicle was encased in fibrinous material and surrounded by yellow fluid characterized as a suppurative exudates that cultured positive for Actinobacillus suis. Unilateral orchiectomy was performed with a hemi-scrotal ablation. Thermography was performed 24 hours postoperatively, revealing an increase in scrotal temperature, but no areas greater than 36 degrees (the normal scrotal temperature for a stallion is less than 35 degrees). In the stallion, thermal injury is predicted to have an effect on sperm production and morphology with a nadir between 25 and 35 days post-insult. Thermography was repeated two weeks after the surgery, indicating the return of normal thermal patterns.

BACK PROBLEMS IN HORSES

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The purpose of this study was to evaluate and characterize the occurrence of lameness in horses. Back problems identified in a clinical exam can be correlated to treatments and outcome assessment of the cases. The equine back includes the axial skeleton from the withers to the sacroiliac joint. Equine back problems are considered a major cause of alterations of gait and performance. Unfortunately, the characterization, localization, and identification of the painful area can be problematic. The incidence of back problems in general practice has been reported as 0.9%. the clinical indications of back problems are highly variable. Equine back problems are encountered, but because of the nature of the problem, can be very difficult to diagnose. Careful examination is always a necessity. Thermography is an invaluable tool in these cases to localize the lesion, but radiography and ultrasonography characterize the injury.

RESTORING CREDIBILITY TO VETERINARY THERMOGRAPHIC EXAMS

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It is a well known fact that veterinarians have a strong influence over how the public accepts new or unfamiliar veterinary diagnostic / treatment regimens. At the present time, infrared thermography is viewed with mixed response by the veterinary community at large. Across the board, it would appear that veterinary infrared thermography (IRT) receives more negative "press" than it does positive "press". Part of the problem is related to mistakes made by thermography practitioners in the past, while another part is due to a basic lack of knowledge and/or lack of personal experience on the part of those making negative comments. Unfortunately, some of it is also based on the current fact that there are some poor and improper practices being promoted to sell IRT cameras; individuals doing veterinary thermographic exams without adequate training and experience; and thermolosgist who are not following proper documentation and protocol procedures. The final area of concern is interpretation without adequate training and experience to do so.

If veterinarians expect to have IRT recognized as a legitimate diagnostic tool that will be widely accepted in the veterinary community, and subsequently by the public. It will be necessary to equate Thermographic results to accurate and repeatable (under similar circumstances to the original exam). This requires proper documentation of complete case history; physical exam with "areas of concern" noted; camera make and model; environmental factors such as time of day, ambient temperature, equilibration time, etc.; facility factors such as floor surface, air currents, windows and doors etc.; patient preparation; special conditions related to an individual animal such as missing hair, scars etc.; other pertinent factors that could affect the interpretation of the IRT images taken.

An adequate number of images for careful evaluation should be taken and stored on the media card in the camera. After the thermographic exam is completed, the images stored on the media card should be evaluated in an analysis capable computer software program. Particular attention should be paid to any apparent or possible artifacts that may have been introduced. If an adequate number of images have been stored for evaluation, then there will be several images with which to evaluate each potential artifact or suspected pathological abnormality. After evaluation of the images, a final report should be generated which includes the written interpretation of the images evaluated along with printed example images of any pathology found. Any "areas of concern" identified on the physical exam should be noted as normal, abnormal, or suspicious etc. Whenever practical, follow-up images should be done to document response to treatment and to help document the practical use of IRT in the veterinary diagnostic and treatment process. Good follow-up adds credibility to the use of IRT in veterinary medicine. This final report should become an integral part of the animal's permanent health record.

Finally, the thermography standards should be widely publicized. As individuals and as an association, we are responsible for how IRT is seen and accepted by the veterinary community and the general public. The establishment of absolute integrity in the entire imaging process, from training of technical personnel to the use of proper examination procedure and documentation, to experienced image interpretation by qualified veterinarians, and generation of an accurate final report, is necessary if we are to gain the respect necessary to be accepted as a legitimate veterinary diagnostic procedure. When we fulfill this responsibility, we will silence all common negative press from which we now suffer.

DYNAMIC EVALUATION OF SADDLE FIT IN HORSES USING REAL TIME THERMAL IMAGING

Waldsmith, JR

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Back pain is one of the primary areas addressed in pain management in humans, but is largely undiagnosed in large animal veterinary medicine. Diagnosis of back pain is limited by a lack of objective techniques and tools with which to do document ailments in and around the spinal column. Active horses in a variety of occupations are frequently noted to resent the application of the saddle by the rider, and are also observed to develop muscle atrophy of the Trapeziu, Latissimus dorsi, Serratus dorsalis, and Gluteal muscles. Poor or abnormal fit and wear of the saddle is potentially a cause of the symptoms observed. Poor fit or abnormal wear can be a manifestation of poor saddle fit for the individual horse, poor saddle construction, or unbalanced equitation on the part of the rider. This paper will demonstrate how pre and post exercise thermal analysis of the horse and the underside of the saddle can serve as a diagnostic tool in identifying these abnormalities, and also provide objective information in their repair and/or treatment.

STANDARDIZATION OF INFRARED IMAGING IN MEDICINE AND ISSUES FOR A REFERENCE ATLAS FOR CLINICAL THERMOGRAPHY

Ring EJF, Ammer K, Murawski P, Wiecek B, Jung A, Zuber J, Azolenik S, Plassmann P, Jones BF

University of Glamorgan, Pontypridd UK,
WIM Warsaw Poland, Lodz University Poland

A joint British and Polish research project has been in progress since 2001. the aim is to establish a framework for an international database of thermal images of the human body. Medical thermography has been developing for 45 years. However, defined protocols for technique and the ability to apply quantitative methods to medical thermographs have been employed only in recent years. Despite the considerable literature referring to diseases and abnormal thermographs, few papers give reliable data on normal findings. There is a common need to establish a reference database of normal thermograms from which the abnormal findings can be reliably assessed. A collaborative project linking our three institutions has been underway for three years. Existing protocols and agreed international standards for technique have been examined to identify sources of error and variability in thermograms obtained from human subjects. The result of this study can be summarized in eight separate areas, and solutions to each area have been introduced and tested.

1.patient preparation and information

2.camera systems, standards and calibration

3.patient position and image capture

4.image analysis

5.image storage

6.image exchange

7.image presentation

8.information, protocols, and resources

Each of these areas were found to be sources of error, artifact, or omission in clinical practice. Any combination of these problem areas led to a lack of reproducibility, and possible misinterpretation of the results. We have now put in place protocols, definitions, and software modifications to correct or minimize the effect of these problems. Each new procedure has been tested and verified. The extended protocols for image capture and analysis have been published on two websites, Poland and the UK with translations into Polish, English, and German. A medical training course has been successfully set up in the University of Glamorgan, , based on these standard procedures and how they are applied in different areas in medicine.

Having clarified the above procedures, we are now in a position to begin the multicentre study to collect thermograms from normal, healthy subjects in order to develop the reference atlas for medicine. We have established an accurate interchange between different cameras and software systems into a common file format that allows the assembly of images together with the necessary quantitative information.

STANDARDIZATION OF RECORDING AND MEASUREMENT OF THERMAL IMAGES

Ammer K

Ludwig Boltzmann Research Institute for Physical Diagnostics, Vienna, Austria

Existing literature lacks information on reference values of temperature distribution on the human body surface. Only few recommendations for body positioning during image recording were published, and nearly nothing can be found on placement of regions of interest for measurement and the reproducibility of such temperature determinations.

Historical proposals by M. Engel and the AAT for body positions and temperature measurements will be reviewed and their drawbacks will be discussed in detail. Finally, the protocol developed at the University of Glamorgan will be presented. A total of 24 views of the body were specified and within these views, a total of 87 regions of interest (ROI) were defined.

The repeatability of some standard views by different investigators and the inter- and intra-rater reliability of temperature readings from selected regions of interest has been investigated. The highest variation in positioning was found in the hands and feet. The face varied in a very narrow range. Individual dimensions of these body regions contribute to the variation of positioning. In the case of dorsal hands, the distance between both little fingers may be longer than the distance from the wrist to the tip of the middle finger. Such a condition prevents the precise positioning in a defined manner. Similar conditions may occur in the views, upper back and anterior knees. According to the results of this investigation, the rules for positioning and image capture of dorsal hands, upper back and anterior knees have been modified.

Inter-rated reliability coefficient alpha and ICC of the ROI "lower arm" and the hourglass shaped ROI at the anterior knee confirmed excellent repeatability of ROI placement. The influence of the angle of view on temperature readings from an identical object will also be discussed.

RAYNAUD'S "COLD" PROVOCATION TEST: A FAIR TEST?

Heusch AI, Ridley I & McCarthy PW

Welsh Institute of Chiropractic, University of Glamorgan. Treforest, Pontypridd. CF37 1DL, UK
Land Instruments, International Limited, Dronfield S18 1DJ, UK

There appears to be no clinical agreement with respect to the current testing methodology for determining the presence of Raynaud's phenomenon. The current tests take no account of the environmental conditions (ambient temperature) and how the person may have adapted to them. The "cold'provocation test itself has been carried out with various provocation temperatures (0°C, 15°C and 20°C) and durations of application (1 or 5 minutes). The temperature related to the digits during the re-warming phase are then recorded. The patient is classified as having Raynaud's if the difference between the digits and palm pre and 10 minutes post 'cold' provocation was -4oC (Collins et al., 1970). In addition, whether the recording device had been calibrated against a traceable standard on a regular basis is often omitted.

To overcome these problems, a LAND Mv infrared camera using two standardized traceable infrared emitters, which is used to calibrate the uncooled focal plane array (160x120 pixels) of the camera, and is therefore in every image. Their temperatures could be altered to give greater flexibility, and emissivity was set at 1.0. Following an explanation of the protocol, volunteers signed a consent form. A university ethics committee ethically approved the study. The experiment took place in a climate controlled room (temp 19) Images of the subjects' hands were

taken at time 0, 1, 5 and 6 minutes. Those subjects showing no noticeable change over this period then placed their hands in plastic gloves and immersed them in water at 18o+/-0.5oC for one minute. After which the hands were removed from the gloves and images taken every minute for ten
inutes, then at five minute intervals. The data was analyzed two ways, firstly by the thermal index (Collins et al, 1970) and then by determining the gradients of individual digits and giving a digit response rather then the whole hand.

OBTAINING VALID AND RELIABLE THERMOGRAPHIC IMAGES IN VETERINARY MEDICINE

Purohit RC, Schumacher J, Smith JW, Pascoe DD

Department of Clinical Sciences, College of Veterinary Medicine;
Department of Health and Human Performance, Auburn University, USA

In comparing the results from thermographic publications in veterinary and human medicine, we have found that there are some studies where reliable standards and equipment were not used. In some cases a simple cause-effect relationship was used to prove their view that thermography was able to diagnose a disease or a syndrome. In lieu of many excellent studies, such claims by a few have given thermography a bad image. Many times the new-comer to the field of thermology has been made to believe that any or all equipment can be used, and simply ignoring the scientific merits for obtaining reliable diagnostic thermograms.

Internal and external factors have a significant effect on the skin surface temperature. Therefore, the use of thermography to evaluate skin surface thermal patterns and gradient requires an understanding of the dynamic changes which occur in blood flow at systemic, peripheral, regional, and local levels. Thus, to enhance the diagnostic value of thermography, we recommend that everyone concerned should follow established, meaningful standards.

We recommend a minimum standard protocol as follows:

1.The environmental factors which interfere with the quality of thermography should be minimized. The room temperature should be maintained between 21 to 26 C. Slight variations in some cases may be acceptable, but room temperature should always be cooler than body temperature and free from air drafts.

2.Thermograms obtained outdoors under conditions of direct air drafts, sunlight, and extreme variations in temperature provide unreliable thermograms in which thermal patterns are altered. Such observations are meaningless.

3.When an animal is brought into a temperature controlled room, it should be equilibrated at least 20 minutes or more, depending on the external temperature from which the animal was transported. Animals transported from extreme hot or cold environments may require up to 60 minutes of equilibration time.

4.Other factors affecting the quality of thermograms are hair coat, exercise, sweating, body position and angle, body covering, systemic to topical medications, regional and local blocks, sedatives, tranquilizers, anesthetics, vasoactive drugs, skin lesions such as scars, surgically altered areas, etc.

5.Various clinical conditions also require use of challenge testing such as to obtain thermograms before and after exercise, response to heating and cooling of the skin surface, and response to various medications.

In conclusion, the value of thermography is its extreme sensitivity to changes in heat and its ability to detect changes. Therefore, it is important to have well documented normal thermal patterns and gradients in all species under controlled environments prior to making any claims or detecting pathological conditions.

PHYSIOLOGICAL FACTORS THAT AFFECT THE EMMITED SURFACE TEMPERATURE

Heusch AI, & McCarthy PW

Welsh Institute of Chiropractic, University of Glamorgan. Treforest, Pontypridd CF37 1DL, UK

The infrared image depends upon two factors: physiological and physical, of which the first is highly variable within the population as a whole. The emitted heat from the exposed skin surface is dependent upon numerous factors such as: previous activity, habitat's temperature, skin thickness, capillarisation, somatotype, hormonal level (female), injury/dysfunction, number of myofascial trigger points, embarrassment, and the temperature of the thermography room. The data we will discuss concerns the relationship between physiological measurements and body surface heat patterns.

The protocol was ethical approved by the University's ethics committee and the volunteers gave their written consent. The subjects disrobed to the required level and waited twenty minutes to equilibrate with the laboratory temperature (22.6±1.3C). We used a standard protocol to minimise non-biological variance.

We found a negative correlation between percentage body fat and whole body surface temperature which when investigated further appeared to show a relationship between somatotype. The highest whole body surface temperature appeared to be male subjects classified as ectomoph/mesomorph and the lowest were associated with the endomorph class which can be explained by altered sympathetic activity, (Grassi 2001). Whereas there appears to be no significant correlation between age of the subject and their average surface temperature ($R = 0.060$), or between BMI and average surface skin temperature ($R=0.031$). In a separate study we found a positive correlation between neck surface temperature and the number of myofascial trigger points.

These results imply that in order to produce a standard thermogram that can be used for bilateral temperature similar but different to expected than more physical measurements should be taken.

CUTANEOUS CIRCULATION AND INFRARED THERMOGRAPHY IMAGING

Pascoe DD., Smith JW,. Kovacs MS, Strecker E, Purohit RC.

Department of Health and Human Performance, College of Veterinary Medicine, Auburn University, AL U.S.A. 36849

The purpose of this presentation is to review the principles of anatomy and physiology of skin blood flow and to relate these dynamic regulatory skin processes to images obtained by infrared thermography. Alterations of skin blood flow reflect a dynamic process that is mediating the heat transfers between the body core and environment and is ultimately responsible for maintaining our body temperature within the critically defined, small range of temperatures for survival. When it is necessary for the body to conserve heat, vasoconstriction of the skin blood vessels allows the skin surface to serve as a layer of insulation and skin temperatures moves towards a state of equilibrium with the environment. Under conditions of excessive heating, the skin blood flow aids in dissipating the heat from the body core to the environment through conduction, radiation, convection, and evaporation of sweat. Infrared thermography provides a surface map of temperatures that are reflective of the regional blood flow. While infrared thermographic imaging is not able to quantify a flow rate (eg…Flow ml/skin surface area), the changes observed in regional skin surface areas can provide valuable physiological and clinical data concerning the skin surface temperature, isothermal regional patterns, and symmetry of the image.

RELIABIITY AND VALIDITY OF THERMOGRAPHIC IMAGING I WORK PHYSIOLOGY

Smith JW, Kovacs MS, Strecker E, Purohit RC, Pascoe DD

Department of Health and Human Performance,
College of Veterinary Medicine, Auburn University, Alabama 36849, USA

Infrared thermographic imaging can be invaluable when studying the influences of environmental stressors on Man's thermoregulatory capacity in the workplace. The skin is a dynamic medium between the body's core and the environment. All heat transfer mechanisms between the environment and the body's core require heat transfers through the skin. Skin's dynamic nature allows for continual changes in blood flow between the core and skin to maintain core temperatures within a very narrow range for survival. Recommended environmental temperatures for workers to work comfortably range fro 16 – 24 degrees C for most types of work. Many occupations require work to be performed under thermal conditions that are outside of the recommended temperature ranges and under the influence of variable relative humidity that may lead to hyperthermia or hypothermia in the individual. Convective heat transfers accomplished through air and water, clothing and barrier outfits (materials and layers), and metabolic heat production of exercise/work will further influence the skin thermal responses. Infrared thermography can be useful in mapping the changes in skin temperature that occur as a result of work or environmental stressors.

THE EFFICACY OF ALUMINUM WEAVE COOLING JACKETS AT REDUCING THERMAL LOAD FOLLOWING EXERCISE IN A HOT ENVIRONMENT

Kovacs MS, Smith JW, Strecker E, Pascoe DD.

Department of Health and Human Performance, Auburn University,
AL. 36849, USA

Limiting the rise in core temperature during recovery from exercise has important medical (heat illness/injury) and physiological (performance) implications for health and safety. The purpose of this investigation was to examine the efficacy of aluminum weave cooling jackets at reducing thermal load following exercise and the effect on surface temperature as measured by thermal imagery. Eight fit males between the ages of 19 and 55 were recruited to participate in this study. The participants were required to exercise on four separate occasions wearing shorts and no shirt in a hot environment (33°C, 25% humidity) until they had attained a rise of one degree Celsius in core temperature (T) from resting level. After each exercise session the participants were required to passively recover during four conditions: No Jacket (NJ); Jacket (J); Jacket Initially Wet (JIW); Jacket Continuously Wet (JCW). During all trials (T), thermal sensation (TS) and heart rate (HR) were measured. Thermal images were also taken immediately post exercise and at five minutes, 10 minutes, 20 minutes and 30 minutes post exercise. All trials produced a rise in HR, T, and TS during exercise and all values decreased after the cessation of exercise. In both wet jacket trials (JIW and JCW) the first five minutes post exercise produced a reduced rise in T while JCW trials provided a greater reduction in the participants HR and TS immediately post exercise and throughout recovery. All three trials that required the use of the jacket (J, JIW and JCW) had reduced body weight loss at the completion of exercise compared to the NJ trials. Immediately post exercise the T in the wet jacket trials (JIW and JCW) did not rise to the same extent as the other trials; however, all trials involving the aluminum weave cooling jackets provided a reduced sweat loss, as indicated by body weight loss, compared to the NJ trials. These results would suggest that the addition of water to the aluminum weave cooling jackets results in similar Tc while reducing HR, TS and reducing the sweat loss during recovery from exercise. This could have important implications for maintaining hydration status during recovery from exercise and competition in hot environments.

INFRARED IMAGING FOR TENNIS SPORTS MEDICINE

Strecker E, Smith JW, Kovacs MS, Pascoe DD

Department of Health and Human Performance, Auburn University,
Alabama 36849, USA

The purpose of this investigation was to evaluate the use of infrared thermographic imaging in assessing changes in skin temperature patterns, determine the efficacy of rehabilitation programs, and monitoring injuries on Division I college male tennis players. Eight participants (two with pre-existing injuries and six injury-free) had eight thermographic images taken at three different occasions: pre-season, mid-season, and immediately post-season. Participants equilibrated for 15-20 minutes prior to imaging for skin temperature at a room temperature of 22 ± 2 degrees C at approximately the same time to prevent the effect of the circadian cycle. Eight different pictures were taken for each subject in various anatomical positions: anterior superior, right superior, left superior, posterior superior, anterior inferior, right inferior, left inferior, and posterior inferior. Images were then compared for evaluation f the efficacy of rehabilitation programs on pre-existing injuries and to assess possible changes in patterns of skin temperature during the tennis season on all athletes. The results show that even though tennis is considered a unilateral sport, the patterns of skin temperature are similar on both sides. We concluded that the use of infrared thermography is beneficial in assessing changes in skin patterns and beneficial on the evaluation of the efficacy of rehabilitation programs during a tennis season in Division I college male tennis players.

THERMOGRAPHY OF SKIN TEMPERATURES FOLLOWING RUNNING AT DIFFERENT INTENSITIES

Harris J., Smith JW, Pascoe DD

Department of Health and Human Performance, Auburn University. USA

The purpose of this investigation was to examine the changes in upper body skin temperature and thermal patterns after running at various intensities. Skin plays a vital role in exercise thermoregulation. Skin is the site of direct exchange between metabolically produced body core heat and the environment. Metabolic heat production increases as exercise intensity increases, resulting in greater need for heat exchange with the environment to maintain safe core temperatures. Infrared thermographic imaging was used to examine changes in mean regional skin temperature and cutaneous thermal pattern changes that occur with various exercise intensities. Six highly fit, trained, male, collegiate cross-country runners (VOmax = 72.6 ±2.9 ml*kg*min) exercised in a thermoneutral environment (20 ºC) at three increasingly intense workloads. Individual workloads were established as: below ventilatory threshold (BVT = 74.9 +/- 4.6 % of VOmax or 15.6 ± 1.4 mets), at ventilatory threshold (VT = 84.4 ± 4.7 % of VOmax or 17.5 ± 1.4 mets), and above ventilatory threshold (AVT = 92.1 ± 3.5 % of VOmax or 19.1 ±- 0.8 mets), as determined by graded exercise testing. Infrared thermographic images were taken pre-exercise (PRE), post-warm-up (WU), and following each of the three workloads. Mean chest skin temperature decreased with increasing exercise intensity (PRE = 31.58 ±0.53 ºC, WU = 30.78 ± 0.43 ºC, BVT = 29.81 ± 0.77 ºC, VT = 29.47 ± 1.01 ºC, AVT = 29.05 ± 1.09 ºC). Abdomen skin temperatures showed a similar pattern. These data agree with previous investigation of skin temperature and exercise intensity. The response of forearm and palm skin temperature to increasing intensity varied between BVT, VT, and AVT. There appears to be a relationship between the skin temperatures and the exercise intensity. Further research including different exercise intensities and blood lactate concentration measurements may provide additional information.

INFRARED IMAGING IN MEDICINE WORLDWIDE

Diakides NA and Diakides M

Advanced Concepts Analysis, Inc., Falls Church, Virginia, USA

The paper give a comprehensive background of the infrared (IR) imaging activities worldwide and the Advanced Concepts Analysis, Inc., involvement in this area since 1994. support for the effort came from The Office of the Secretary of Defense (OSD), Defense Advanced Research Projects Agency (DARPA), Army Research Office (ARO), and the Office of Naval Research (ONR). Investigated major challenges for wide acceptance of this modality and introduced approaches to overcome these. One of the major thrusts was to explore the potential of integrating advanced IR technology with smart image processing and automated target recognition (ATR). Progress and results of this effort are discussed. Some of the principal medical applications and imaging methods, as well as ongoing research worldwide are highlighted. Early detection of tumor formation with infrared imaging is emphasized and the importance of this is discussed. The pre-commercialization program sponsored by the Deputy Assistant Secretary of the Army for Installations and Environment, Environmental Safety, and Occupational Health, is a new initiative.

THERMAL IMAGING OUTCOME ASSESSMENTS WITHIN EVIDENCE BASED PRACTICE

Haber C

Alternative Medicine Pain Management;
Monroeville, Pennsylvania, 15146, USA

The rapidly changing environment of accountability requires the physician to implement procedures to evaluate their individual system of health care to ensure efficient and cost effective quality of therapeutic methods utilized. Thermal Imaging outcomes in clinical practice enable the health care provider to document the objectifiable results of the treatment administered. The providers will soon have to make available convincing scientific evidence of validity, reliability, and clinical utility of the methods of practice. Thermal imaging, performed in a scientific reproducible manner, provides such utility and supports medical necessity and appropriateness of the treatment provided. This evidence, which is readily appreciable by the patient and judicial system, supports the need for continued care or the attainment of maximum therapeutic benefit. The third party pay system is able to readily discern that only therapeutically directed and effective care is provided with the patient being monitored for responsiveness.

MEDICAL INFRARED IMAGING – RECOGNIZING FACTORS CONTRIBUTING TO A DISEASE STATE

McCahon P

Medical Infrared Digital Imaging Pty., Ltd.TURNER ACT 2612 Australia

MIDI continues with the "whole body" imaging approach discussed in my last presentation to the AAT in 2002. In that paper I concentrated on the benefits of whole body imaging to clients with undiagnosed, chronic pain.

In this paper I will present a number of case studies illustrating additional benefits of this "whole body" protocol to clients. I will discuss the possibility that IR examination can detect potential problems before the client is aware of any symptoms of disease. I will also discuss the potential for this technology to detect thermal abnormalities contributing to symptoms of disease, before currently accepted diagnostic standards recognize the development of a disease state.

We seek to provide our clients with the best opportunity to address all factors contributing to potential health problems before their quality of life is affected by the presence of a disease state.

Case studies to be presented include a 40 year old male, active, fit, who suffered MVA years previous. He presented for whole body IR imaging after undergoing extensive tests for chest pain/heart disease. He also complained of migraines and was on medication for high blood pressure and asthma. Electrocardiograms, cardiac stress tests, angiograms, etc. were conducted, all were negative. His doctors gave him the 'all clear' attributing his symptoms to stress and depression.

MIDI identified significant thermal abnormalities throughout the neck and thoracic regions. Treatment of those areas identified as abnormal patterns has resulted in symptoms of asthma and chest pain resolving within one month. Migraines have diminished in quantity and intensity.

II. ABSTRACTS OF POSTER PRESENTATIONS

BREAST HEALTH

V. Hunt

Co-Founder Medical Thermography, Inc., Canada

This presentation will look at the role of the naturopathic doctor in dealing wit the alarmingly high levels of breast dysplasia and pathology; how to have earlier quantifiable and repeatable functional assessment using infrared digital thermography; how naturopathic medical applications can address to the causative factors underlying breast dysplasia, and how to integrate with other health care providers for case management. Bringing 25 years of clinical experience to her clients, Dr. Verna Hunt has used proactive technologies to assess breast health and further developed protocol methods to address issues of breast dysplasia in relation to overall health.

Outline of Presentation

The alarming and increasing breast pathology in industrialized nations currently affects the health of one in seven women in her lifetime. The effect of society at large in terms of health care dollars, loosing skilled people in the work force in the prime of their careers, family units loosing primary parent/ caregivers /providers, and quality and quantity of life for the woman affected is devastating.

This presentation will address the key role naturopathic doctors have in educating people about normal breast function at the many stages of life, safely assessing breast physiology using various methods of assessment tools and techniques, and encompassing and strategically utilize naturopathic modalities to optimize breast function in relationship to the entire person.

THERMOGRAPHIC EVALUATION OF THE CANINE ATHLETE

Gillette RL, Angle C, Smith JW, Pascoe DD, Purohit RC
Veterinary Sports Medicine Program, Department of Clinical Sciences
Department of Clinical Sciences, College of Veterinary Medicine
Department of Health and Human Performance, College of Education
Auburn University, Alabama, USA

There is a high measure of thermal symmetry in the normal body. Therefore, abnormal temperature asymmetry's can be easily identified. Thermography has a high sensitivity to pathology in the vascular, muscular, neural, and skeletal systems.

In this preliminary study, thermography was used to look at thermal patterns and gradients in clinically normal greyhound dogs. Further studies were done to evaluate condition versus unconditioned greyhound dogs. Some thermal differences were observed between the two groups. Further analysis will need to be conducted to fully understand the difference between the groups.

One dog in this study had a chronic tarsus problem due to an old fracture and another dog had developed a mammary tumor. The tumor was revealed by the thermograph. The other dog broke the right tarsal joint three years ago and has had an altered gait since. Her thermograph demonstrated a presence of variation in temperature between the right and left hock. This asymmetrical measurement could be related to muscle deterioration. The unbalanced back legs demonstrated that her gait was not a normal, healthy one. Further research should be performed to evaluate the benefits of thermography in evaluation of the canine.

SPORTS MEDICINE: EFFICACY OF PRE-SEASON SCREENING

Pascoe DD, Smith JW, Kovacs MS, Strecker E, Purohit RC
Department of Health and Human Performance
College of Veterinary Medicine, Auburn University, Alabama 36849, USA

The purpose of this presentation is to discuss the importance and implications of pre-diagnostic screening images in the sports medicine setting. Images need to be taken as part of the pre-season, pre-participation medical screening. The pre-season imaging sequence can be reviewed for regional temperatures, thermal patterns, image symmetry, and compared to the athlete's medical history/record (current and past injuries, symptoms, medications, etc.). Unlike the general population, athletes are compelled to train and continue to compete with injuries, and resting recovery is a limited option. Over the past several years we have been taking pre-participation and after-injury infrared images and categorized them in the following sport categories: Contact (football, hockey, diving, gymnastics, baseball, softball, volleyball, basketball, cycling, field-high jump/pole vault) and non-contact (running, tennis, swimming, aerobic dance, weight training, golf). The pre-season images provide a bench mark from which injuries can be assessed, the efficacy of various modalities (ice, ultrasound, photonic stimulation, contrast baths, etc.) can be determined, and rehabilitation of an athlete can be monitored.

News in Thermology

UK Symposium on Medical Infrared Thermography

Prof. F. Ring (Glamorgan), Helen McEvoy (NPL), Dr. P. Campbell (Ninewells / St. Andrews), Kevin Howell (Royal Free) are the members of the organising committee of the Thermology Group in the UK Thermography Association for another meeting on medical infrared thermography. This Symposium will take place on Wednesday 3rd November 2004 at the National Physical Laboratory in Teddington, Middlesex, UK.

Provisional topics are: SARS detection by infrared thermography, traceability issues in medical thermography, Veterinary applications of thermography, Thermography in medicine and research network for medical thermographers.

The deadline for submission of abstracts was 16th July 2004. Abstracts should be limited to 250 words and submitted in Word format via e-mail to:

Mr. Kevin Howell, Royal Free Hospital. Tel 020 7472 6550, e-mail for abstracts and enquiries: k.howell@rfc.ucl.ac.uk.

All accepted abstracts will appear in number 4 of Thermology international.

The completed registration form (page 120) should be sent to:
Melanie Williams, Clubs Manager,
Division of Engineering and Process Control,
National Physical Laboratory, Queens Road, Teddington,
Middlesex. TW11 0LW. UK.

5th Course on Medical Thermal Imaging

The 5th Course on the Theory and Practice of Infra Red Thermal Imaging in Medicine, held on June 30 - July 2, 2004 at University of Glamorgan, Pontypridd, UK, attracted participants from Europe (Norway, Portugal, Romania; Slovenia, United Kingdom) and America (United States, Canada) (figure1)

The overall impression of the course, rated on a scale from 1 to 10, was 2.6 based on feedback forms. General comments were very favourable such as

• Excellent course

• Overall good

• Course was overall well organised and I enjoyed the opportunity to meet people in different fields and from different countries

Symposium of the Austrian Society of Thermology

The 17th Symposium of the Austrian Society of Thermology and the Ludwig Boltzmann Research Institute of Physical Diagnostics is scheduled for the 2nd October 2004. The venue for this meeting will be at the campus of the University of Vienna, originally built as the General Hospital of Vienna in the late 18th century. Parts of the building are dated back to the time of the emperor Josef II, son of Maria Theresia.

Figure 1
Participants of the 5th Course on the Theory and Practice of Infra Red Thermal Imaging in Medicine

Main theme of the symposioum is "Infrared imaging as an outcome measure". Papers on applications of thermal images in drug trials, and in angiology, rheumatology and physical medicine will show the advantages of thermal imaging as a method for evaluation of various treatment modalities.

Experts in the field from UK, Poland, Slovakia and Austria have expressed their interest in participation. However, work related to temperature measurement outside of the main theme is also welcome.
For further information, please contact

Prof Kurt Ammer MD, PhD, Ludwig Boltzmann Research Institute for Physical Diagnostics, Hanuschkrankenhaus, Heinrich Collinstr. 30, A-1140 Vienna, Austria,

Phone: +43 1 914 97 01 Fax:+43 1 914 92 64
Email: KAmmer1950@aol.com or lbfphys@a1.net

Web Page of the AAT

During the last Annual Meeting of the American Academy of Thermology at Auburn University, the world wide web presence of the AAT was introduced. The site at http://www.americanthermology.org provides information the history of the American Academy of Thermology, . names and contacts of officers of the society, and the code of ethics of the AAT. Members of the AAT can upload their addresses for contact and also articles on infrared imaging.

The AAT rules for certifications of thermography laboratories and specialities are also provided. The section on news/meetings is still under construction. A list of links to other societies, manufacturers, journals and other resources is available and functioning..

AAT Certification Course

The American Academy of Thermology established review course/examination for the members to obtain credentialing and CME credit. The course attendance provides credit towards ongoing competency in thermology. The format of the presentation includes basic science, clinical cases, as well as areas of quality assurance, laboratory accrediation and reimbursement issues. The faculty consists of both American and International members. The following is the list of candidates who sucessfully completed the course. Credit from this course is also applicable towards technician certification and thermologist certification. The course directors included ABT certified members of AAT and ABT certified technologists.

Annual Meeting (November 8, 2002) Thermography Re- view Course/Examination
1.Jan Crawford

1. Linda Fickes DC
2. Denise C. Nichols
3. Carla Manley
4. Pip McCahon
5. J.M. Molloy
6. Natasha Monin, MD
7. Kelley Martin
8. Jan. L. Crawford, RN, BSN
9. John Eric Smith
10. Pauline Cobble
11. Mary M. Trent
12. William Schroeder, DC.
13. Dr. Elizabeth H. Santiao
14. Dr. L. Sanatiago
15. Tirza Deflinger

Annual Meeting (April 15-18, 2004)Thermography Review Course/Examination
1.Jan Crawford
2.Jean Koek
3.Douglas Harding
4.Dr. Donna L. Harper
5.Nancy Gardner Heaven
6.Margaret Durand
7.Robert Ensley, DC
8.Katherine Evans
9.Mary Donna Lowery
10.Pip McCahon
11.John W. McDaniel
12.Beth McDougall, M.D.
13.Craig A. Mueller, DC
14.K. Pramila Vishvanath
15.Sophia Wilcox
16.Lee Weissman

Any person interested in attending similar future courses, please contact

Srini Govindan, M.D.,
Executive Director American Academy of Thermology,
email:GovindanA@cs.com

14th^th International Conference on Thermal Engineering and Thermogrammetry (THERMO)

The International Conference on Thermal Engineering and Thermogrammetry (THERMO), which started in 1977 from annual national symposia and became an international conference in 1987 running in a circle of three years, is now a series of biennial meetings. The next conference is announced for 22-24th June, 2005 in Budapest, Hungary. This congress is intended to be an event of the interest to all engineers, scientists, physicians and researchers who are involved in the solution of thermal or energy related problems, and in the applications of thermal imaging.

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, common practice of thermal engineering, protection of human environment, medical and veterinary applications and remote control through infrared sensors.

The conference is hosted by the House of Technology in Budapest (Bp.V., Kossuth Lajos tér 6-8) located near the House of Parliament and the Danube. More information about the conference venue and hotel accommodation will be sent after the arrival of the Registration Form.

The language of conference and abstracts is English. Oral presentation of papers and also a poster session will be organized.

The preliminary programme (until June 2004) includes more than 30 papers from 28 countries around the world. Duration of each presentation will be limited to 15 minutes and additional time for discussion will also be provided. The English translation of lectures not read in English should be submitted at the registration desk on the spot. LCD projector and computer with Windows OS for Microsoft Power Point format presentations is available. (Pleas note, that using your own computer is not allowed.)

Those intending to attend the conference are kindly invited to send a registration form (page 121) to:

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

For any further information and personal inquiries please contact the following address:

Dr. Imre BENKÕ,
H-1112 Budapest, Cirmos u. 1, 6/38, Hungary,
Phone/fax: +361-310-0999, E-mail: ibenko@freestart.hu

Veranstaltungen (Meetings)

September 6-8, 2004

Annual Conference of the Institute of Physics and Engineering in Medicine (IPEM) in York, U.:K.

Tuesday 7.9.2004
Clinical Temperature: 09.00 - 12.50

Human body temperature measurement: past, present & future - F Ring, Pontypridd

Infrared thermal imaging and autologus breast reconstruction surgery -J Mercer, Tromsoe, Norway

Non-invasive regional cerebral thermometry by magnetic resonance spectroscopic imaging - J Thornton, London

Comparison of thermography and laser Doppler imaging for assessment of vascular responses to cold stress - S Hiscock, Bath

Temperature effects of thermotherapy determined by infrared measurements - K Ammer, Wien, Austria

Phantom target for validating microwave radiometry as a medical thermometry technique - A Levick, Teddington

Thermometry without mercury - a review of emerging methods and manufacturer's data - D Crawford, Cardiff

Traceability and calibration in temperature measurement: A clinical necessity - G Machin,Teddington

Healthcare practioners´s knowledge abd use of tympanic thermometry - J.Evans, Pontypridd

The vagaries of ear temperature - P.McCarthy, Pontypridd

Round Table discussion

October 2, 2004

17th Thermological Symposium
of the Austrian Society of Thermology and the Ludwig Boltzmann Research Institute for Physical Diagnostics

Venue: Institut für Ethik und Recht in der Medizin
ehem. Kapelle Altes AKH,
Spitalgasse 2, Hof 2; 1090 Wien

Main Theme: Outcome measure thermal image

Is thermal imaging a proper outcome measure ?-K.Ammer

Thermal imaging as outcome in drug trials- E.F. Ring

Temperature measurement as outcome measure in trials for Raynaud´s disease - K Ammer

Thermal imaging in monitoring treatment for angiopathies - T.Maca

Information: Prof Dr Kurt Ammer PhD
Ludwig Boltzmann Research Institute for Physical Diagnostics, Heinrich Collinstr. 30, A-1140 Wien
Tel: + 43 1 914 97 01 Fax: +43 1 914 92 64
Email: lbfphys@a1.net or KAmmer1950@aol.com

October 14-17, 2004

Veterinary Thermal Imaging Seminar

Presented by The Mid-Coast Veterinary Medical Association, local chapter of The California Veterinary Medical Association.

Sponsored by Vetel Diagnostics, San Luis Obispo, CA and The American Academy of Thermology

Speakers: Tracy Turner, DVM, Jim Waldsmith, DVM, Mike Walsh, DVM, Natanya Nieman, DVM,
Kelly Martin, BS, Gary Orlove,P.E., Mike Corcoran.
(specific topics subject to change)

Tuition: $350.00 per participant.

CE Credit Offered.

Course curriculum qualifies for academic portion of Veterinary Thermal Imager certification requirements by the AAT.

Location: Sands Suites Motel and Conference Center
1930 Monterey St. SLO, CA. 93401
Tel: 1-800-441-4657, 805-544-0500,
email: www.sandssuites.com

October 14
Course in Veterinary Thermal Imaging

Morning Session

8:00-8:30 Welcome

8:30 - 9:00 Introduction to the American Academy of Thermology and The American Board of Thermography. - Govindan

9:00 - 10:30 Thermal Imaging in Veterinary Medicine Today.- Waldsmith

10:30 - 10:45 Break

10:45 - 12:00 How to obtain thermal images for studies on equine patients - Martin

12:00 - 1:30 Lunch

Afternoon Session

1:30 - 2:15 Safety concerns while performing thermal examinations on animals.- Neiman/Purohit

2:15 - 2:30 Break

2:30 - 4:00 Anatomy and Physiology topics as they relate to veterinary thermal imaging - Neiman/Purohit

4:00 - 4:15 Break

4:15 - 5:30 Thermal Imaging Equipment and Software used in veterinary thermal imaging today. Orlove

October 15

8:30-9:30 Overview presentation of Human Thermal Imaging today. The American Academy of Thermology and the certification process for veterinary thermal imaging.- Govindan

9:30-10:15 Thermal Imaging in marine mammals today Walsh

Break

10:30-11:15 History of Thermal Imaging and Instrumentation in veterinary medicine - Turner

11:15-12:00 Thermal Imaging applications in Zoo and Wildlife parks today - Walsh

LUNCH

Afternoon session

1:30-2:30 Normal mature equine thermographic examination - Turner

2:30-3:00 Normal Juvenal equine thermographic examinations -Turner

Break

3::15-4:15 Reading through artifacts in the thermographic exam - Turner

4:15-5:00 Utilizing routine thermal examinations as a means of early injury detection on a Thoroughbred Racing Farm - Neiman

5:00 Wine and Cheese hosted by Vetel Diagnostics.

October 16
Morning Session - Specific Equine Anatomic Conditions

8:00-8:45 The Foot- Turner

8:45-10:00 Tendons and Ligaments- Turner

Break

10:15-11:00 Joint Disease- Turner

11:00-12:00 Back and Muscular Conditions- Turner

12:00- 1:30 LUNCH

Afternoon Session

1:30-2:15 Saddle Fit -Corcoran

2:15-2:45 Dynamic Examinations using the High Speed Treadmill - Waldsmith

Break

3:00-5:30 Individual Case Presentations

* These presentations will document how thermal imaging is used as part of a comprehensive diagnostic work up in veterinary applications. Presentations will qualify

October 17 Informal wet lab session

9:00AM- 2:00 PM At The Equine Center, San Luis Obispo
4850 Davenport Creek Road, SLO, CA. 93401. (805)541-6367

This is a session for individuals to get one-on-one assistance in thermal imaging technique, camera function, software issues, and report generation. The session will begin with a demonstration of how to perform the basic equine thermal examination and a brief review of artifacts. The Equine Center staff, as well as representatives from Flir and Vetel will be available to work with participants individually with specific issues they may have need for further education on.

Accommodations: Sands Suites and Motel (800) 441-4657

930 Monterey St. San Luis Obispo, CA 93401

www.sandssuites.com

A block of rooms is available at a special group rate. The group name is Vetel. The rates are $59 single - $69double and $89 for a 2 bedroom room suite. Reservations need to be made prior to September 23, 2004 to receive the discounted rates. The hotel only provides a shuttle service from the airport via Central Coast Cab Company. An extended Continental Breakfast is included with the room rate. We can help arrange for your transportation back to the airport.

San Luis Obispo's airport code is SBP. The Airport is served by United, American, Delta and America West airlines. All major car rental agencies have service available in SLO.
Please contact Kelly Martin at Vetel Diagnostics for any additional information you require. 1-800-458-8890, 805-781-7691 or Veteldiagnostics@aol.com

October 22-24, 2004

"50 Jahre Deutsche Gesellschaft für Thermographie und Regulationsmedizin e.V."

Freitag, 22.10. bis Sonntag, 24.10.2004 in
Bad Nauheim, Hotel Dolce am Kurpark

Freitag, 22. Oktober 2004

Geschichte d. Thermographie u. d. Gesellschaft
Vorsitz: Berz

14.30 Begrüßung, Eröffnung der Tagung Berz
Vorstellung des Programms
Grußworte

15.00 Rückblicke 1. Teil, wie alles anfing Schwamm

Rückblicke 2. Teil, Beiträge der Physik Reeh

Rückblicke 3. Teil, Standardisierung Rost

Rückblicke 4. Teil, die letzten 25 Jahre Berz

16.00 "Back to the roots?"Infrarot-Thermographie damals und heute Berz

16.20 Pause, Besuch der Ausstellungen

Geschichte 2, Thermographische Methoden
Vorsitz: Sauer

16.40 Kontakt-Thermographie damals und heute Sauer

17.00 Regulationsmedizin und Regulationsthermographie David

17.20 Erfahrung, Evidenz und Evaluation; Thermographie und Wissenschaftlichkeitskriterien — Ammer

17.40 Kombination von Kontaktthermographie und Infrarot Imaging: Stärken und Schwächen — Walker

18.00 Regulationsthermographie in der Zahnheilkunde. Optimierung der Validität — Dahl

18.20 Forschungsprojekt zur Variabilität infrarotthermographischer Bilder im Zyklusverlauf — Wegert

18.40 Pause, Besuch der Ausstellungen

19.00 Sektempfang des Bürgermeisters — Bgm. Rohde

20.00 Festabend im Spiegelsaal, gemeinsames Abendessen

21.00 Festvortrag
Älter werden ohne zu altern? Über Hormone Healthy Aging und Prävention — Wolf

Samstag, 23.Oktober 2004

Schwerpunkt Kontaktthermographie 1
Vorsitz: Dahl

9.00 Begrüßung und Einführung in das wiss. Programm — Berz

9.10 Der Immunstatus im RTG — Sauer

9.30 Quanterologische Homöopathie und RTG — Walker

9.40 RTG-Messpunkte am Rücken — Sanden

10.00 RTG in der Psychiatrie.Überführung der linearen Diagnose und Therapie in eine zirkuläre, interdisziplinäre Heilkunde — Wyss

10.20 Was leistet die RTG bei Herderkrankungen — Sauer

10.40 Verlaufskontrollen mit Hilfe der RTG — Disterheft

11.00 Pause, Besuch der Ausstellungen

Schwerpunkt Kontaktthermographie 2
Vorsitz: Walker

11.30 Abschlussbericht zum BMBF-VDI-FE-Projekt: RTG 1999-2001/ Stand 2004 — van Leendert

11.50 Darmsymptomatik und Schilddrüsenregulation im RTG — Müller

12.00 Thermographische Überprüfungen der Redox-Therapie-Langzeitbeobachtungen — Wyss

12.20 Klassische Homöopathie und RTG — Dobler

12.40 Mitgliederversammlung der DGTR, ggf. Verlegung auf 18.20

12.40 Mittagspause, Besuch der Ausstellungen

Schwerpunkt Infrarot-Thermographie 1
Vorsitz: Ammer

14.30 Prinzipielle Unterschiede zwischen Infrarot-und Kontakt-Temperaturmessungen — Berz

14.50 Bildgebende Infrarotverfahren in der Medizin (Infrarot Imaging) - Geschichte und Überblick — Ammer

15.10 Infrarot-Sensoren zur integralen Areal-Messung- Geschichte, Entwicklung und Stand der Technik — Berz

15.30 Infrarot Regulations Imaging (IRI) der Mammae -neue Chancen für die senologische Prävention — Sauer

15.50 MammoVision - die standardisierte und validierte Infrarot-Mammographie — Wolf (Berz)

16.10 Pause, Besuch der Ausstellungen

Schwerpunkt Infrarot-Thermographie 2
Vorsitz: Wegert

16.40Spezifität und Sensitivität der MammoVision- wissenschaftliche Untersuchungzur Treffsicherheit — von Lorentz

17.00 Langzeitkonstanz von individuellen IRI-Mustern -ihre diagnostische und prädiktive Bedeutung — Wegert

17.20 Ganzkörper-Infrarot Regulations Imaging (IRI)typische Muster im Abdomen, am Rücken und an den Beinen — Berz

17.40 Fallbeispiele: Erkannte Mammakarzinome dank IRI der Mammae — Sauer, Walker, Wolf, Wegert

18.00 Pferde klagen nicht - stumme Leiden mitInfraVet sichtbar gemacht — von der Wense

18.20 Mitgliederversammlung der DGTR

20.00 zwangloses Treffen der Kongressteilnehmer in Bad Nauheimer Lokal

Sonntag, 24. Oktober 2004

9.00 Begrüßung und Einführung in das Workshop-Programm — Berz

9.15 parallele Workshops

Workshop 1:Intensivseminar für Assistenten (korrekte Kontaktmessungen) — (Helferin Walker)

Workshop 2Intensivseminar MammoVision
- Bedienung von MV-Scan — Berz, Berz J
- Einführung in MV-Expert

Workshop 3:Intensivseminar "Praxisrenner"
- Neutropan-Therapie bei Tinnitus — Walker
- Hydro-Colon-Therapie

Workshop 4Thema wird noch bekannt gegeben — Sauer, Teuber

Workshop 5: Thema wird noch bekannt gegeben — Dahl

Workshop 6: Thermographie bei Pferden mi t InfraVet — von der Wense

- Erkennung stummer Leiden
- Sichtbarmachen von Beanspruchung
- Dokumentation von Therapieerfolgen
- optimierte Gesundheitsuntersuchungen

Pausenregelungen werden in den Workshops selbst getroffen; Ende der Workshops gegen 12.30

12.30 Abschluss der Jubiläumstagung, Resümee Berz
Verabschiedung der Teilnehmer

Teilnahmekosten

Kongressteilnahme Fr. und Sa.
- Mitglieder DGTR kostenlos
- Gäste 125,- Euro

Tageskarte Freitag
- Gäste 50,- Euro

Tageskarte Samstag
- Gäste 100,- Euro

Kosten für den Festabend
- Mitglieder DGTR kostenlos
- Gäste 50,- Euro

Kosten für die Workshops So.
- Mitglieder 50,- Euro
- Gäste 100,- Euro

Die Workshopkosten sind jeweils bei den Kursleitern zu entrichten.

Pausengetränke und Gebäck sind in den Kongresskosten enthalten.

Anreise und Unterkunft sind von allen Teilnehmern selbst zu begleichen. Im Hotel steht eine begrenzte Anzahl ermäßigter Zimmer zur Verfügung. Bitte mit dem Hotel selbst in Verbindung setzen.

November 3, 2004

UK Symposium on Medical Infrared Thermography

An NPL T²PAC meeting,

National Physical Laboratory, Teddington, Middlesex, UK

Organising committee: Prof. F. Ring (Glamorgan), Helen McEvoy (NPL), Dr. P. Campbell (Ninewells / St. Andrews), Kevin Howell (Royal Free).

Complete the registration form (page) and send it to:

Melanie Williams, Clubs Manager, Division of Engineering and Process Control, National Physical Laboratory, Queens Road, Teddington, Middlesex. TW11 0LW. UK

Contact for enquiries: Mr. Kevin Howell, Royal Free Hospital., Tel 020 7472 6550, k.howell@rfc.ucl.ac.uk

I wish to register for the UK Symposium in Medical Infrared Thermography. Please tick the relevant box:

3 November 2004

☐ **£60** Standard rate

☐ **£45** for postgraduate university and all NHS staff

☐ **£25** for UK Thermography Association members as at 1.5.2004

☐ **Free** for TPAC members

☐ Tick here if you would like further information about being an **exhibitor** at the meeting

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2005

June 22-24, 2005

14th International Conference on Thermal Engineering and Thermogrammetry (THERMO) Budapest, Hungary

APPLICATION FORM

for prospective authors and participants

(If you wish to be put on the mailing list and to receive Conference Announcements, please complete and return the following form as soon as possible, but not later than 15th September, 2004 to MATE Secretariat.)

Name and title:

(e.g. Prof., Dr., Dipl. Ing., etc)

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(Organization, firm)

Mailing address:

(city, street, country, ZIP code)

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(Please tick the appropriate boxes)

- ☐ Please send further information
- ☐ I plan to attend the Conference
- ☐ I intend to submit a paper/poster with the following title:
- ☐ abstract enclosed
- ☐ abstract will be sent until 15 September, 2004.
- ☐ I intend to present (a) film(s), VHS video, etc.
- ☐ I intend to exhibit (a) poster(s) during the workshop-session
- ☐ I intend participate in the exhibition
- ☐ Please send further copies of Second Announcement to the following addresses:

P.S.: The organizers strongly recommend Internet exchange: e-mail: ibenko@freestart.hu

Authors are requested to provide electronic version of their abstract (two pages, A4 format) and camera-ready papers as .doc or .pdf attached file to: mate@mtesz.hu

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A-1170 Wien
Österreich

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- ☐ UK Thermography Association
- ☐ Italian Association of Thermology
- ☐ Polish Society of Thermology
- ☐ Deutsche Gesellschaft für Thermographie

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