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"Hot shots"

Thermographic imaging

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Introduction

The normal internal temperature in resting man is maintained within very narrow limits inspite of wide variations in environmental temperature. Under steady state conditions heat flows from production sites in the body to cooler tissues. Blood distributes this heat to the body surface from where it is dissipated to the external environment by radiation, convection and evaporation.1
As an object absorbs energy its temperature increases. The object then dissipates (emits) this energy. A good absorber is a good emitter. As long as the temperature remains above zero (-2730C) all objects are infrared incandescent (glow in the infrared wavelengths as a result of heat). Hence, infrared radiation is constantly being emitted, absorbed and re-emitted by every object in the environment. Human skin is almost a perfect emitter of infrared radiation and its temperature varies widely as a result of environmental changes.(2)
By studying the skin temperature patterns from the patient's body, the diagnosticians gain a direct index of the metabolic activity in the various parts of the body.(3)

Thermography:

"therme"-heat+"graphy"-a method of recording Thermography is a technique for sensing and recording on film, hot and cold areas of the body by means of infrared detectors that reacts to blood low.

Applications:

Dentistry:
- TMJ dysfunctions
- Trigeminal neuralgia
- Myofacial irritation
- Facial casaulgia
- Periodontitis
- Periostitis
- Osteomyelitis
- Cellulitis and abscess

Medical:
- Breast disease
- Arteriosclerosis
- Inflammatory diseases
- Musculoligamentous spasm
- Neuritis
- Skin abnormalities
- Raynaud's disease
- Cold pain/injury

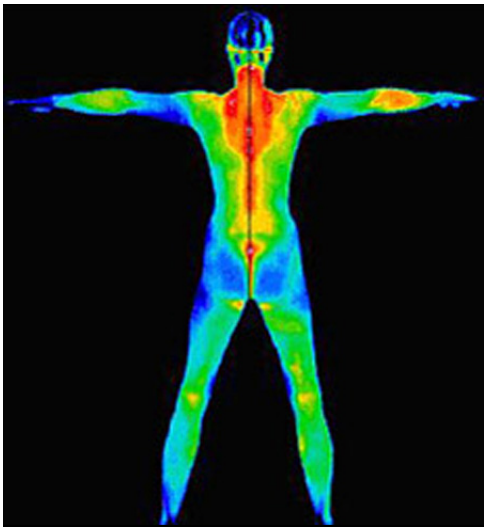

Fig. 1: Full body thermogram

Fig. 2: Teletherm camera with flat panel display. Thermographic devices convert heat energy on the skin in to electric data on a computer monitor. It simply registers skin surface temperature from the capillary heat conduction through the skin

Fig. 3: Thermocouple and bimetal probe. By studying the skin temperature pattern from the patient's body, the diagnosticians gain direct index of the metabolic activity in various parts of body. Disturbances in the energy conversion process and reduced response to the stress stimulus show up in the Computerized Regulation Thermography (CRT)

Fig. 4: HUGHES PROBEYE 4300 THERMAL VIDEO SYSTEM

Fig. 5: The beginning? The ancient Egyptian used fingers as scanners and Brain as a computer

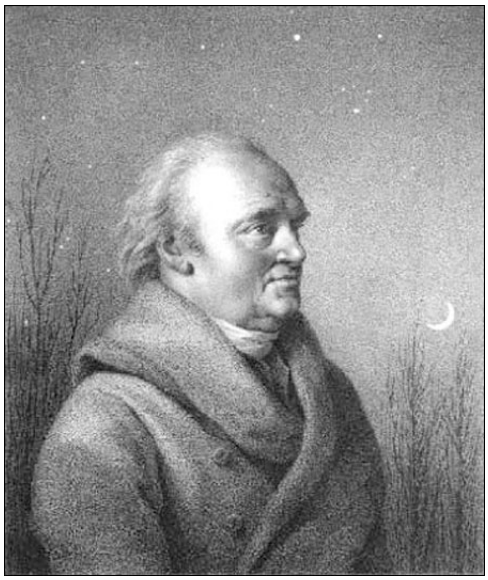

Fig. 6: Real beginning: Discovery of Infra-red radiation by Sir Willam Herschel in 1800

Objectives

To show that modern medical and oral and maxillo-facial thermographic imaging can also be used as an adjunctive diagnostic tool.

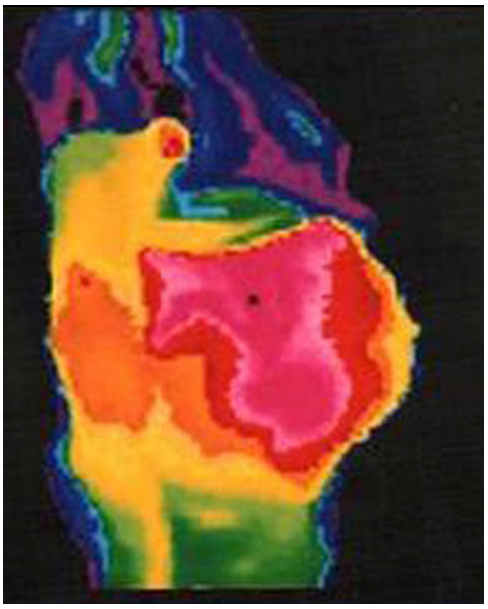

Fig. 7: Medical thermography – fetal image

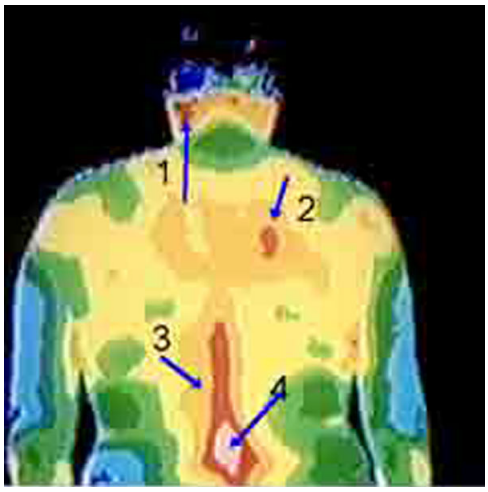

Fig. 8: Pre-treatment fibromyalgia

Fig. 9: Post-treatment fibromyalgia

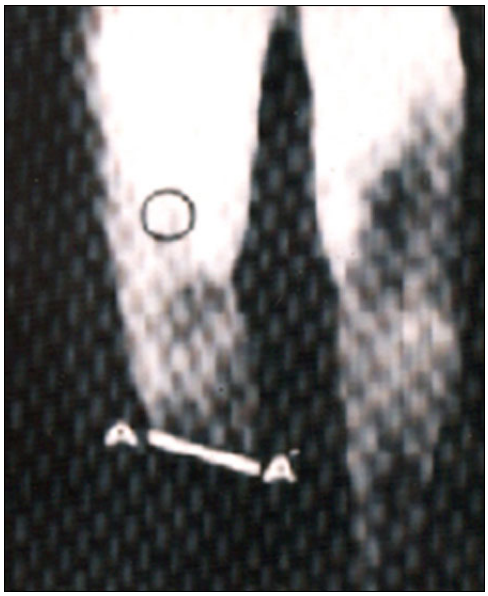

Fig. 10: Severe ischaemia

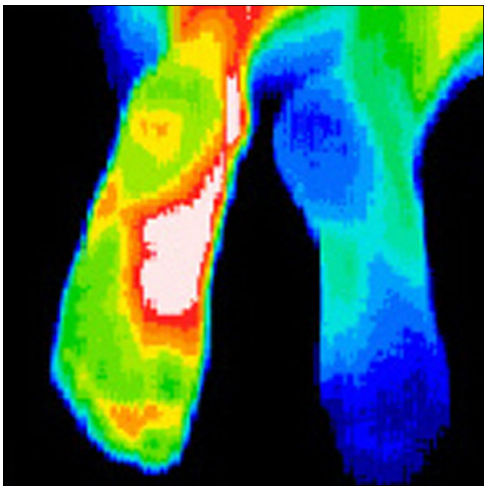

Fig. 11: Complex regional pain syndrome – foot

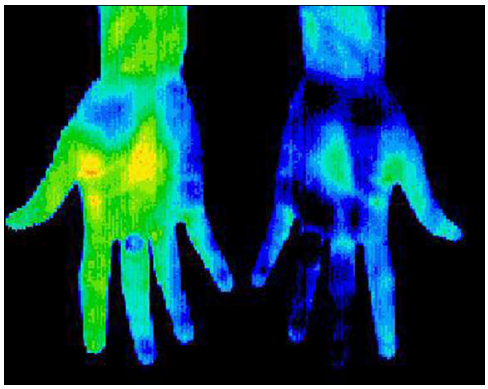

Fig. 12: Complex regional pain syndrome – hands

Fig. 13: Vascular disease of legs

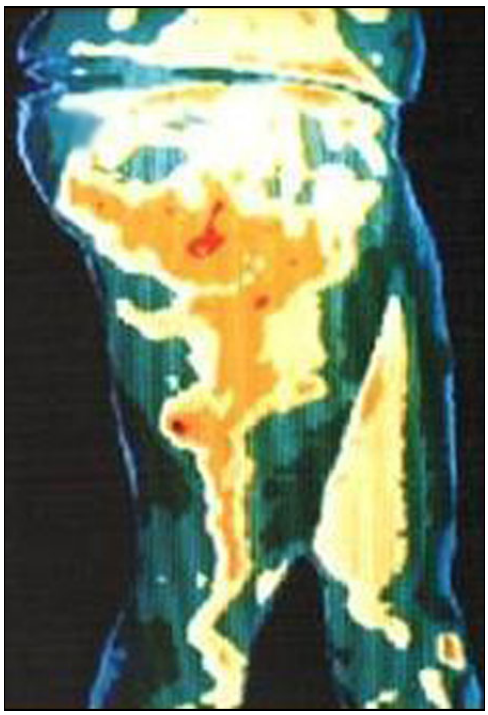

Fig. 14: Vascular disease of legs

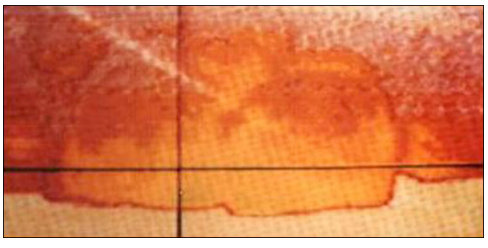

Fig. 15: Oral maxillo-facial thermography – temperature gradient for normal teeth

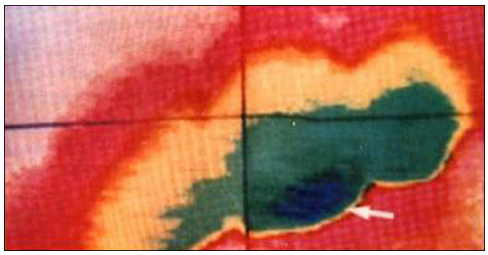

Fig. 16: Thermogram of a non-vital tooth

Fig. 17: Maxillary sinusitis

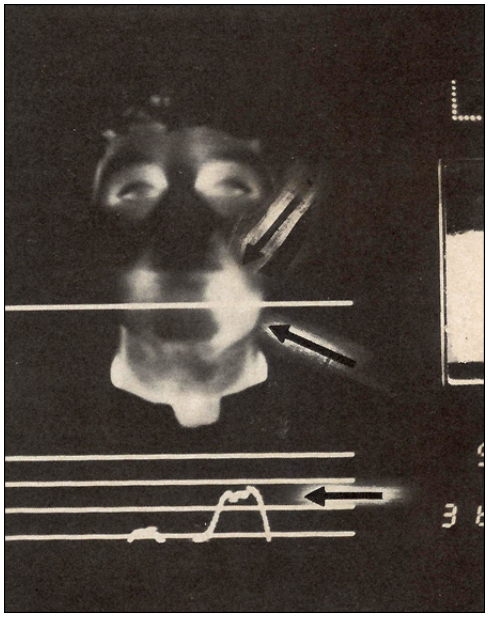

Fig. 18: Submaxillary cellulitis

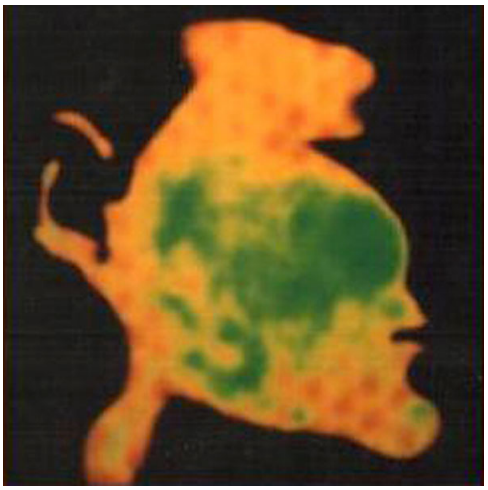

Fig. 19: Myogenic fascial pain

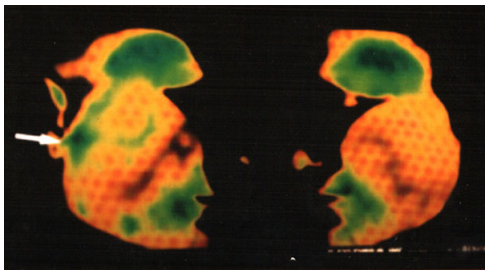

Fig. 20: Thermograms of TM joint

Material and Methods

An infrared (IR) temperature measuring device consists basically of a system for collecting radiation from a well-defined field of view, and for focusing it on to a detector which transduces the radiant energy into an electrical signal.

There are two categories of detectors. They are
1. Thermal detectors, which respond to the heating of the sensor, and
2. Photon detectors, in which the initial absorption of infrared photons results in the freeing of bound electrons.(1)

Scanning of the scene in front of the detector can be accomplished by a variety of ways.
The signal derived from the detector is amplified and used to modulate the intensity of the electron beam of a Television monitor type picture-tube display unit. The thermal image shows relative temperature differences in a continuous range of gray tones from black to white. The hot area to be displayed may be white or black (inverted mode) depending on the preference of the user.
Clinical Thermography using Liquid crystal (Contact) thermography (LCT) Or Infrared (Non-Contact) thermography (IT) should be carried out in a draught-free, constant temperature environment. A cool ambient temperature of 19±10C is the optimum to ensure reliable standardization and operation of the imaging equipment. It is important to strictly follow as many of these factors, firstly, Expose the area of examination. Secondly Keeping the subject at rest for 12-15 minutes in constant temperature (70-750C) room. Third factor is keeping the room free from air currents and heat generating objects1 and lastly subjects being investigated by thermography must have clean, dry skin free from cosmetic cream. Perspiration on the skin reduces the apparent surface temperature.1

Results

Disease or trauma can affect the skin temperature, sometimes causing a temperature increase or in some conditions causing a reduced temperature. Thermographic feature suggestive of abnormality is localized area of temperature increase either unilateral or bilateral of about 1.5K or more on over the suspected pathologic area.1

Blood vessels which lie within 2 or 3 mm of the surface can be imaged photographically using reflected light and infrared sensitive film, but deeper vessels carrying warm blood also affect the surface temperature distribution1. Fat in contrast to muscle is a poor conductor or a good insulator. On the thermogram, skin over the fat appears colder than skin over muscle. Hair is avascular and appears colder thermograms ("cold spots"). Conversely skin over muscle large veins, bruises, hematomas, infections and injuries appear hot ("hot spots"). Heavy scar tissue and uninfected cysts appear cold as a result of low metabolism and relative avascularity.2

Inspite of its severe limitations, liquid crystal thermography (LCT) has been claimed to yield meaningful results in the evaluation of thermal abnormalities of the face due to orofacial disorders. The only way the surface temperature of skin can be measured without contact is by remotely measuring the infrared blackbody radiation that it emits.4
Thermography is being used to investigate a variety of clinical problems. The most important amongst these are:

1. Screening for occult malignant disease.
2. Delineation of the extent of known disease.
3. Identification of areas with abnormal temperatures, which might be the cause of functional impairment of underlying organs or glands.
4. Monitoring the effects of various forms of therapy such as reconstructive surgery, radiotherapy or treatment with hormones or drugs.
5. Assessing the prognosis of certain disease.
6. Identify functional deficiencies and vascular disorders.
7. Studying the effects of acute or chronic trauma.
8. Physiological research such as energy metabolism and peripheral vascular investigations.(1,3)

Conclusions

The application of temperature measurement and thermal imaging to assess health and disease (medical thermology) has continued to advance since antiquity up to the present day. The use of thermography has been minimal principally due to technological inadequacies of previous thermal imaging system. However with the ever-developing advancement in technology, current systems are capable of producing real time highly sensitive digitized thermal images. This development has led to take an increased use of newer thermographic imaging both medical and dental research. Since its first application, Infrared thermography has shown considerable potential within a number of dental disciplines including Periodontology, Restorative dentistry, Prosthodontics, Oral surgery and Oral Medicine.

Literature

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Abbreviations

IR = Infrared
LCT = Liquid crystal thermography
IT = Infrared thermography

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