Applications of infrared thermography in medicine
reported by members of the UK Thermography Association Medical Section www.ukta.org

Infrared imaging or “thermography” will be familiar to many as a tool for inspection of electrical installations and buildings, and other non-destructive testing applications. The use of thermography within the medical field is perhaps less recognised. Whilst debate continues about the utility of thermography for detecting breast cancer and SARS, infrared imaging has become well established in a variety of other medical disciplines. Below we report just some of the innovative applications of thermography in medicine.

**Enhanced Laser-Tissue Interaction Using Infrared Thermography**
from Roderick Thomas, Faculty of Applied Design and Engineering, Swansea Institute

Infrared thermography has utility for the assessment of laser-tissue interactions, especially during photothermolysis (whereby laser radiation is selectively absorbed by the target tissue and not by the skin) for hair depilation and the treatment of vascular lesions.

The efficacy of laser application is partly dependent on the skill and experience of the laser operator. Often the effects of photothermolysis occurring in the dermis are difficult to predict. However, with the intervention of thermography more control is achieved, reducing the occurrence and intensity of unwanted side-effects such as burning or missed treatment areas. A simple example of tissue sensitivity to differing laser light is illustrated in fig.1.

Tissue optical and thermal processes are also investigated by a Monte Carlo model led by Kelvin Duncan, (Swansea Institute), which is validated by thermographic measurements. Fig. 2 is an example of thermographic data of hairs preferentially heating and skin temperature remaining at a lower level.

**Denervation Effect on Infraspinatus Muscle Using Thermography**
from John Allen, Freeman Hospital, Newcastle upon Tyne

Thermography can assess the quiescent function of fistulae in renal dialysis patients. Thermal images collected from a renal patient with a brachial fistula in the right arm are shown in fig. 3. The fistula essentially forms a short circuit between an artery and vein to allow access for haemodialysis and at high blood flow rates. However, if the fistula is incorrectly formed or has excessive blood flow then problems can occur, including vascular steal as is demonstrated in this patient.

In fig. 3A) The right hand is significantly cooler than the contralateral side, and consistent with the degree of clinical vascular steal, and B) The bilateral similarity in thermal presentation is also lost when the upper arms are compared, the hot regions on the right side are mainly related to warmer arterialized blood returning to the heart.

**Dynamic Thermography as a Reliability, Non-Invasive and Easy Method for Monitoring Perfusion in Free Flap Surgery: Preliminary Results**
from Line Boe, Setså and James Mercer, Faculty of Medicine, University of Tromsø, Norway

Thermography can assess free flap viability during reconstructive breast surgery. Fig. 6 illustrates the technique involved in reconstruction of a new breast, in which a flap of skin and fatty tissue from the patient’s own abdominal area is transferred to the thoracic wall. The stomach flap receives its main blood supply from branches of the deep inferior epigastric artery. During the preparation of the flap all blood vessels, except for one branch of the deep inferior epigastric artery and its vein, are cut and sealed. This means that the stomach flap is now dependent on a single artery and vein for its blood circulation. Finally these two vessels are cut and the entire flap is transferred to the thoracic wall where the artery and vein are connected (“anastomosed”) to a branch of the internal mammary artery and vein. The outcome of the operation is dependent on the success of the anastomosis, and infrared thermography is of help in determining if the anastomosis has been successful.

The series of images in fig. 7 were taken at the most critical point during the surgery, that is just after completion of the anastomosis of the donor to the recipient vessels. During the operation there is a period of time, which can be as long as two hours, during which the flap has been receiving no blood at all and cools down, as seen in the first infrared image, taken at the moment when the anastomosis was opened. In the following images it can be seen that the anastomosing process has been successful and many warm areas are visible as the flap rewarms. The rapid rewarmed pattern immediately tells the surgeon that blood flow has been established.

**Results from a Clinical Thermography Image Database**
from Carl Jones, University of Glamorgan, Pontypidd

Thermography has been in medical use since the 1960s, but despite many different applications and studies, a database of normal human thermograms is not available. To construct such a database, volunteers were recruited and screened for normality using the Euro-Qol (EQ5D) questionnaire. Twenty four standard thermographic views of normal volunteers were then recorded, using standard masks in each case to minimise the variability in position between subjects. Normal subjects were divided into categories, for example males aged 18–30, so that images of the standard views for each category could be combined. Before combining the images of different subjects, the images were warped to allow subjects of different shapes to fit exactly into the standard masks. The combined images provide information about the mean and variability of temperature in the standard views for a given category of normal subjects. The mean image for the category of males aged 18–30, total body view, is seen in fig. 4, the standard deviation is shown in fig. 5.

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