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Infrared Thermography in the Hands Applied to the Investigations of Diseases - A Mini-Review

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Abstract: ***Thermography is knowledge to measure variation temperature in different part of the body and correlate with illnesses. Infrared Thermography (IRT) is a technique that allows for the rapid and non-invasive recording of radiation energy that is released from the body. Despite this, the use of IRT applied to thermography analysis yet is a new approach, and, mainly and especially when the focus is on hand analysis.The purpose of this mini-review is to present this technique in determining of the temperature of the hands applied to the investigations of diseases.***

Keywords: Infrared thermography, human hands, diseases

1. Introduction

It is known that the average temperature of the human body varies between 36.1 ^{o}C–37.2 ^{o}C, and what suits is the temperature stay at ≈ 36.5–37.0 ^{o}C. In the last few years it has been widespread that the variation in the temperature of the human body is of fundamental importance to detect diseases early. The foundation of thermography work is related to changes in skin surface temperature. Skin temperature changes as a result of physical processes, natural physiological changes, or diseases. This change of thermal properties in a particular organ or body surface is used to detect the disease. Some works employed thermography measurement to diseases study.[1]–[4]

IRT through which the body temperature and its distribution are measured through microwave radiation (average peak 9–10 μm) emitted by the surface of body.[5]The IRT is very useful for detecting temperature variations in the human body.[6]–[9]

IRT is a safe, non-invasive and low-cost technique that allows for the rapid and non-invasive recording of radiating energy that is released from the body. IRT measures this radiation, directly related to skin temperature. Since the early 1960s it is known that heat patterns, shown in thermography images taken with IR cameras, provide information about physical anomalies, such as cancer, infection, eye diseases, diabetes and pain. However, only in recent years, with technical advances in infrared cameras, new human applications of IRT have been possible.[10]–[15]

The temperature of the skin on the hands is useful for detecting changes in the human body and alerting to possible installed diseases, and for that, IRT is very important. The purpose of this mini-review is to present this technique in determining of the temperature of the hands applied to investigations of diseases.

Infrared Thermography and hands

In 1987, Dupuis pointed out that fingertip thermometry may be used in occupational health examinations and that IRT may yield more information on the development of disturbances in peripheral circulation along the finger length and may be used in special clinical work.[16]Steele et al. investigated the temperature of the hands of patients with chronic liver disease and controls using a liquid crystal contact thermography system. The patients were categorized according to Child's score (Child–Pugh scoreis used to assess the prognosis of chronic liver disease) and significant differences in resting hand temperature and appearance were observed. However, with regard to autonomic function, no significant difference in right-hand temperature, thermographic appearance or warm-up rate was detected between those with and those without autonomic neuropathy. The authors conclude that autonomic nervous system dysfunction is not the predominant cause of these changes.[17]Gautherie presented clinical studies of the vibration syndrome using a cold stress test measuring finger temperature and conclude that temperature-measuring cooling tests performed under well-defined, standard conditions provide significant data for grading the severity and assessing the reversibility of Raynaud phenomena (medical condition in which the spasm of the arteries causes episodes of decreased blood flow and usually affects the fingers), and for detecting subclinical vasomotor disorders in asymptomatic patients.[18]Zontak et al. argued that exercise has a noted effect on skin blood flow and temperature, and performed a study with activity subjects (age ≈ 25.8±0.7 years) to characterize the normal skin temperature response to exercise by thermographic imaging. The results showed that the thermographic skin response to exercise was characterized by specific pattern which reflects the dynamic balance between hemodynamic and thermoregulatory process.[19]Coughlin et al. presented a work that analyzed the potential cold provocation thermography (CPT), using IRT, to investigated hand-arm vibration syndrome (HAVS). The authors concluded that the method employed and CPT provided strong objective evidence to support the clinical diagnosis of HAVS.[20]

Infrared thermography was used for examinationthe skin temperature in the dorsal hand of office workers. The objective of the study was characterizing potential differences in cutaneous temperature of the office workers with upper extremity musculoskeletal disorders and without. The infrared thermography appeared to distinguish between the groups of subjects with keyboard-induced cold hand symptoms presumably due, at least partially, to reduced

blood flow.[21]Jankovic et al. proposed, in that time, a novel method of dynamic infrared thermography for assessing the dynamic response of microcirculation during rewarming to investigation HAVS. (Its neurovascular component is Vibration-induced White Finger (VWF), a type of secondary Raynaud´s phenomenon which manifests itself as episodic blanching of the fingers of the response of the cold). The procedure of examination of subject was base on cold provocation in controlled environment followed by thermographic recording of the rewarming process. The results allowed conclude that the method proposed was useful as a follow-up test in individual diagnostics of HAVS.[22]Packham et al. examined the reliability of an inexpensive infrared thermometer and measurement points in the hand for the study of skin temperature asymmetries (STAs)in the diagnostics of complex regional pain syndrome (CRPS). It was found the readings taken by an inexpensive handheld infrared thermometer had both good inter-rater and intra-rater reliability. The results indicated too that the intraclass correlation coefficient is high. However, the authors claim that a larger study to measure STAs in the hand with an infrared thermometer is warranted to investigate this clinical measurement technique for the assessment of CRPS in the upper extremity.[23]Cavalheiro et al. investigated whether infrared thermography is able to measure temperature changes in hands of patients with leprosy and also if there is a correlation among temperature, sensitivity and muscle strength. The infrared camera FLIR A325 and Therma CAM Researcher Professional 2.9 software were used to measure the temperature. The room was air-conditioned, maintaining the temperature at 25 °C; the distance between the camera and the limb was 70 cm. The vasomotor reflex of patients was tested by a cold stress on the palm. The results showed it was possible to observe changes in the temperature of the hands of patients with leprosy, even in those who had no observable deformities. Infrared thermography was able to detect these temperature changes, highlighting the potential of this technique as a non-invasive tool for early diagnosis of neuropathies caused by leprosy.[24]House et al. realized a study to investigate the performance of IRT of finger re-warning after cold water simulation in according with the International Organization of Standardization guideline (ISO guideline) as a diagnostic test for vascular component of HAVS in the hands. The authors conclude that IRT of the hands using the ISO recommended cold water simulation did not perform well as a diagnostic test for vascular component of HAVS.[25]

An overview of the distribution of skin temperature in obese and normal weight people, with the emphasis on the hand skin temperature was presented. The studies relating to the correlation between regional physiological characteristics and body composition showed the skin temperature of the extremities (hands) is elevated in obese people in order to compensate for the lower heat loss in the body region. One of the methods for measuring hand temperature in the selected articles at work is the IRT.[26] Maki et al. performed a prospective study employing hand thermography in patients undergoing radial arterial access (TRA) using infrared thermography. (Radial artery access, it means that will be use the radial artery in the wrist as the entry point for the catheter for coronary angiography and intervention). Despite these benefits, there has been an ongoing concern about potential detrimental effects on radial artery structure, endothelial function as well as hand function after TRA. The authors concluded that TRA is associated with a temperature change in both catheterization and non catheterization hands.[27] Gilchrist writing about the work of Maki et al., mentions that the while IRT raises more questions than answers, there is some good news. The question that remains is why the hand temperatures increase in both instrumented and control hands did, and additional research is likely to provide the answer.[28]

2. Conclusions

Currently, several studies have reported the use of thermography to measure variation temperature in different part of the body and correlate with illnesses. Despite this, the use of IRT applied to thermography analysis yet is a new approach, and, principally and especially when the focus is on hand analysis. However, it can be noted that IRT is of relevance in monitoring diseases based on the variation in hand temperature. Despite the good results found in the studies reported in this mini-review, there are still some gaps to be filled, which, with the improvement of technologies and new investigations, will make IRT a very useful technique in detecting temperature variations in the hands in order to make a diagnosis clinical and to give support to disease diagnostic/treatment.

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