THERMOGRAPHY IN DENTISTRY

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ABSTRACT

Thermography is a non-invasive, radiation-free imaging technique that can be used to assess oral health and diagnose various tooth and jaw diseases. Method

Includes detection of infrared radiation emitted by the body that can be used to generate a detailed image of the temperature distribution on the skin surface.

In oral medicine and radiology, thermography is used to identify various medical conditions such as Oro-facial pain, TMJ disorders, oral cancer, and various other disciplines of dentistry. It has been shown to be effective in assessing the efficacy of treatment and monitoring and Healing progression which makes it a holistic tool of diagnosis.

INTRODUCTION

Thermography is a technique of measuring the distribution of skin temperature over the body over an extended period of time, whereas thermology is the investigation and implementation of bio-thermal processes to evaluate various complications and state of normalcy. It is a non-contact, non-invasive technique that makes use of an object's heat to identify, visualize, and document thermal trends and temperature all over the surface of the object. It also uses images to assess thermal changes visually. Before any alterations in anatomy can be seen, thermography detects physiological and functional modifications in tissues. Thermography may be used to examine all patients because it has the ability to detect changes in pathology before radiographs and ultrasound, both commonly used conventional diagnostic tools.1Due to its non-invasive, non-radiative nature and the promise of a quick inspection speed, thermography is an alluring non-destructive technology (NDT) for the assessment of defects and anomalies.2

HISTORY AND FUNCTION:

Sir John F. W. Herschel, whose father Sir William Herschel made the original discovery of infrared light in 1800, first documented the gamut on the infra-red side of the red around the year 1840.4According to Wien's law, the frequency at which the greatest energy is emitted depends on the body's temperature. All objects, including the human body, emit infra-red radiation. Consequently, the temperature can be established by measuring the infrared rays emitted by surface of the skin.3

TYPES:

Based on the method of application, thermography can be classified to,

Semi-quantitative contact method:

*Liquid crystal thermography

Non-contact, quantitative IR detection techniques are grouped as follows:

* Infrared tele-thermography

*Dynamic tele-thermometry

*Facial tele-thermography

Semi-quantitative contact method: Liquid Crystal Thermography

A thermostat made of flexible sheets of rubber and cholesteric crystals arranged in multiple layers and fixed in a frame is used in liquid crystal thermography. Additionally, these blankets have an inflation feature to help the heat-sensitive surface better follow the contours of the body. (1,5,6,7)

Quantiative, non-contact methods:
Infrared tele-thermography:

It is a non-contact technique for measuring temperature in which the detector is placed remotely at a specific location.

Dynamic tele-thermometry:

The ability of the fast fourier transformation (FFT) spectra to project the underlying temporal thermal behaviour in terms of thermoregulatory frequencies is the distinguishing trait of dynamic area tele-thermometry (DAT).9

Facial tele-thermography:

Heat emission is directly proportional to cutaneous vascular activity, producing enhanced heat output on vasodilatation and decreased heat output on vasoconstriction, and has been demonstrated to be a physiological indicator of the underlying health or disease. Infrared tele-thermography of the face may therefore serve as an utterly safe, non-invasive diagnostic technique that can assist in differentiating specific clinical problems.10

ADVANTAGES AND DISADVANTAGES OF THERMOGRAPHY:1

Advantages:

I. The various advantages of thermography are,

II. Non-invasive in nature

III. Easy examining of the patient

IV. Minimal examination time

V. Colour changes with a clear contrast (gradient: 0.05°C)

VI. Due to its real-time functionality, stationary objects can be scanned very quickly, and thermal patterns that change quickly can be recorded.

VII. There are numerous ways to record thermograms. Which would be preserved in digital forms for a longer time.

***Disadvantages:**

There are disadvantages of thermography that should be taken into considerations

I. A high price level is typical for high-quality cameras.

II. When application is on certain objects, particularly those with unstable temperatures, images can be challenging to interpret correctly.

III. The majority of cameras have measurement precision of 2% or worse.

IV. When the medium is divided by glass, plastic, etc., it is impossible to measure the interior temperature. possible to measure only surface temperatures

V. For some surveys, there must be a temperature variation.

VI. With distance and angle of vision, sensitivity and resolution decline.

VII. Training and maintaining proficiency takes effort.

INDICATIONS AND CONTRA-INDICATIONS:1

INDICATIONS:

1. Mapping of the anatomical regions of the face and oral cavity.

2. Following the recovery post treatment by monitoring.

3. Tumours, Defects and any other anomalies in Oro facial region

CONTRA-INDICATIONS:

1. In patients with fever and sunburn, accurate thermal image analysis is not possible; it is therefore advisable to postpone tele-thermographic facial studies again until acute phase has passed

2. The facial scars that occur can come up as pathological hypothermic lesions which may be misleading at times.

Application of thermography in dentistry:

In patients with chronic orofacial pain:

Ratt and his co-workers created a classification system for chronic pain sufferers in 1996 using telethermographs. When determined anatomic area (T) values ranged from 0.0 to +0.250C, they classed them as normal, hot when it was >0.350C, and cool when it was 0.350C. The result is categorised as ambiguous when the value of the chosen anatomic location ranges from 0.26 to 0.350C. Moreover, they discovered hot thermographs and cold thermographs and normal thermographs had distinct clinical diagnosis.(1,10)

Hot thermographs:

(1) Sympathetically maintained pain,

(2) peripheral nerve mediated pain

(3) TMJ arthropathy

(4) maxillary sinusitis.

Cold thermographs:

(1) peripheralnerve-mediated pain

(2) sympathetically independent pain

Normal thermographs:

(1)cracked tooth syndrome

(2) trigeminal neuralgia

(3)pre-trigeminal neuralgia

(4) psychogenic facial pain

Dental abscess and Cellulitis:

A considerable temperature difference between the two pathologic states was seen in a study that compared the thermal imaging temperatures for facial cellulitis and dental abscess. The study found that for abscess and cellulitis, the temperature differences between the infected and contra-lateral unaffected side were $1.49 \pm 1.0$and 2.4 ± 1.9, respectively. The larger spread and greater tissue damage brought on by cellulitis were the primary causes of the higher disparities between facial cellulitis and dental abscess. Yet the authors acknowledged that their study had limitations, mainly a limited sample size.11

Applications in analysis of TMJ:

It is possible for the masticatory muscle, the TMJ, and the articular disc to all simultaneously be involved in the pathological presentation of temporomandibular dysfunctions which manifest in multiple ways and primarily cause pain . Despite previous efforts, all of these characteristics make it difficult to design an ideal diagnostic technique. One

of these techniques, infrared thermography, can be used to diagnose various temporomandibular dysfunctions, such as osteoarthrosis , It has been shown in 2013 by Delaine Rodrigues-Bigaton , Almir Vieira Dibai Filho, Ana Cláudia de Souza Costa, Amanda Carine Packer, Ester Moreira de Castro18 that there are links between TMJ arthralgia and the thermal changes in the surrounding areas, which were initially disproved by a study conducted in 2004 by Fikackova, H. and Ekberg, E.19Thermography investigation of a normal temporomandibular joint (TMJ) revealed uniform thermal trends with a mean T value of 0.10C. Patients with internal derangement as well as TMJ osteoarthritis, on the other hand, displayed T values of +0.40C.(1,12)

Peri-Implants:

The success of dental implants is greatly influenced by the initial healing stage of the complicated peri-implant bone healing process. The least traumatic implant pocket preparations—both mechanically and thermally—should be performed in order for things to go as positively as feasible. It is essential to use external irrigation systems alongside saline solution (physiological saline at 4°C) of the kind of physio dispenser because the thermal values in the area close to the perforation hole of the bone typically reach around 56°C during the process of preparation for the implant insertion. At this temperature, alkaline phosphatase is distorted, slowing the rate of bone healing and occasionally even causing osteonecrosis.13

Application in orthodontics :

When orthodontic brackets are electro-thermally debonded, the pulp's temperature rises from 16.8 to 45.6 °C, posing a thermal risk. Thermography is helpful in confirming this. In order to examine the T values among active orthodontic patients, temporo-mandibular dysfunction (TMD) patients, and asymptomatic controls, it was seen that thermography can differentiate with TMD apart from those receiving active orthodontic treatment. (1,14,15)

Application in Prosthodontics :

The results of a pilot study by Nayar et al on two groups of edentulous patients one group who did not wear a complete denture (A) and one group who did show that the edentulous patients in group (B) wearing complete dentures have average temperature values of 37.66 in the maxilla and 37.37 in the mandible, that are closer to the normal oral temperature(16). The average oral temperature is between 37.6°C and <37.8°C (98.6°F to 100°F). The distorted and traumatised state of the soft tissue is typically the first indicator of destruction to a residual ridge; osteoclastic deformation caused by pressure is primarily brought on by circulatory disruption in the nutritive tissue of the bone. Thus, blood flow estimation will provide a frame of reference for us to comprehend the alterations to the bone in the residual ridge. The mucosal temperature varies along with the amount of blood flow. Blood flow and anomalies in temperature distribution are connected. Non-contact thermography can be used to measure this temperature change because it contains a wealth of diagnostic data.16

Cracked tooth syndrome:

A vital posterior tooth that has an incomplete fracture that involves the dentine and possibly extending into the pulp is referred to as having cracked tooth syndrome (CTS). Visual inspection of CTS mostly depends on the dentists' experience and expertise; as a result, there is a substantial risk of missing cracks, particularly in cases of early-stage tooth decay. Infrared thermography technology application can help find small cracks (4-35.5 m). Local friction that takes place as a result of vibration's effect causes heat to be produced because the smaller fractures will be vibrated by ultrasonic power (the detection angle and amplitude must be within 45° and 0.89 W, respectively). The thermal imager's activity will then enable the visualisation of dentin micro-cracks. However, this technique has considerable drawbacks when trying to find large fissures.(2,17,20)

Other applications of Thermography in dentistry:

- Monitoring of endodontic therapies
- Assessing the tissue's response to any latest dental material
- Diagnosis of every type of inflammation at oro-facial region
- Acute and chronic periodontitis
- Sinusitis
- Tumours in orofacial region
- Myofacial pain dysfunction syndrome

Conclusion:

The testing and staging of numerous head and neck dysfunctions are aided by thermography. The distinctive value of thermography is the ability to

examine both qualitatively and quantitatively, which aids in the methodical estimation of illness development. Thermography will undoubtedly re-emerge as a special research technique in dentistry in the near future thanks to the development of fresh equipment and state-of-the-art facilities.

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