

# Thermography as an Additional Method in Dental

## Diagnostics. Literature review.

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### Abstract

**Aim:** The aim of this article is to present the contemporary clinical data about thermography as a viable diagnostic tool in dental medicine.

**Materials and methods:** The research relied on PubMed Publications, National Center of Biotechnology Information and ResearchGate.

**Results:** A list of articles, concerning the modern application of thermal imaging in the field of general dental medicine, are reviewed. The authors conclude that the method is very useful in the diagnostic process, treatment planning and patient follow-up.

**Conclusions:** Thermography is the diagnostic method of choice in dentistry, used much more frequently in recent years. Bulgarian authors are extending its application in different directions in dentistry. Our aim is to present the current application and to set the cornerstones of the method based on shared clinical experience.

**Keywords:** thermography, dental medicine, focal infection

### Introduction

Thermographic testing is a noninvasive imaging method that registers the exact emitted infrared radiation and allows the mapping and analysis of the exact temperature distribution on the surface of certain object. It obtains temperature measurement using thermal imaging cameras and subsequent image analysis (1, 2).

Thermal images show changes in body temperature that may correlate with changes in local blood supply and tissue metabolism. Most pathologic processes in the body are accompanied by changes in the temperature: inflammation, necrosis, neoplasms, regeneration etc. The temperature of the body determines the intensity of the infrared radiation.

The obtained thermograms are presented as pseudo-color projections, which facilitate the image analysis.

## Aim

The aim of this article is to present the contemporary clinical data about thermography as a viable diagnostic tool in dental medicine.

## Materials and methods

The research relies on publications in Google Scholar, PubMed and ResearchGate, in English and in Bulgarian.

## Results

The qualities that give advantage to thermography in medical research field are safety, noninvasiveness, lack of any pain or discomfort, there are no known contraindications for patients with systemic diseases or pregnant women. It saves time, carries enough information and allows comparison of results due to the application of sophisticated software analysis. That minimizes the subjective interpretation of the images.

Infrared thermography (IRT) has proved itself as a reliable diagnostic tool in the general medical field, and especially in the facial region. In dental medicine thermography is often applied in analysis of a variety of oral conditions: odontogenic fields of disturbance created by infection, cancers, diseases of the temporomandibular joint (3, 4), maxillary sinusitis and disorders of salivary glands. It is a useful tool of assessment of orofacial pain, differentiate vital from non-vital teeth, assessment of socket healing progress after therapies such as photobiomodulation therapy (PBMT) (4) or photodynamic therapy (PDT) (5, 6, 7).

Thermography can also be used to assess chronic orofacial pain and determine the condition of thermally damaged dental pulp after the use of the Electro Thermal Debonding (ETD) method (8).

Gratt et al. reported that, IRT of chin is an effective method to diagnose inferior alveolar nerve (IAN) deficit (9). They reported that, subjects with IAN deficit have a mean  $\Delta T$  value of 0.5 °C whereas subjects with no IAN deficit have symmetrical thermal patterns, which can be attributed to the blockage of vascular neuronal vasoconstrictive messages (10).

Benington et al. also used IRT for monitoring changes in bone temperature during drilling process for implant site preparation (11).

Madura et al. investigated temperature during sterilization of root canal using Nd:YAG laser (12).

Other applications of infrared thermography in the domain of dental medicine include effects of post-surgical inflammation (13,14) and evaluation of carotid occlusal disorder (15).

One of the key applications of thermography in the maxillofacial region is the detection of focal infections. Focal infections are restricted areas of infection and can be difficult to diagnose using traditional methods, as they may not manifest with obvious symptoms.

According Daria Wziatek-Kuczmik et al., who presented a study aimed to determine the effectiveness of infrared thermal imaging for the detection of asymptomatic odontogenic inflammatory response in patients with a high risk of systemic infections, thermography appears to facilitate the assessment of inflammatory process by displaying temperature differences between the affected and unaffected regions. The authors found that the mean temperature difference between the periapical regions of the suspected and contralateral teeth was found to be the greatest at 30 s. of mouth opening. The difference between temperature values

obtained for suspected and contralateral teeth in the study group and similar measurements performed for the control group was statistically significant (1).

A new classification of patients with persistent orofacial pain was compiled using thermograms. According to temperature differences between left and right side, the thermograms were categorized as normal, cold and hot (between 0 and 0.25°C, 0.35°C and less, or greater than 0.35°C respectively). The article reported the clinical diagnosis of cold thermograms as sympathetically independent pain and the clinical diagnosis of hot thermograms as peripheral nerve-mediated pain, arthropathy of the temporomandibular joint, or maxillary sinusitis.

Bruno Veloso Fracasso et al., used thermography to analyze facial temperature distribution in women with chronic migraine. The authors found significant temperature asymmetry in patients with right-sided unilateral headaches, especially in the right frontal and temporal regions (16).

Nilanjan Dey et al. highlighted several limitations of working with IR cameras such as the need of high quality expensive equipment for more accurate high-resolution images. Thermal imaging directly detects only surface temperatures and shows the momentary state of the organism. In addition, it is affected by obesity and the depth of the scanned region. Deeper tissues need to be further investigated by combining different medical imaging modalities. Other disadvantage is the requirement of subjective reading of the image and advancements in image analysis and processing, with higher sensitivity and specificity.

Therefore, thermography should be combined with other medical imaging methods. Due to it being noninvasive, radiation-free without surface contact, it proves to be helpful in medicine and dentistry. Thus, thermal imaging is complementary to X-rays, ultrasound and three-dimensional scanning techniques such as computed tomography (CT) and magnetic resonance images (MRI). The captured thermal images are used in diagnosing injury and pain, circulatory pathology, detecting tumors and in monitoring treatment (17). Ionildo Sanches et al. presented an innovative image fusion method between different imaging modalities, such as or X-ray, CT and MRI, together with IR thermal images. The combination of these two medical imaging modalities offered a new 3D imaging technique that combined anatomical (MRI or CT) and functional (the body's surface temperature) information. They concluded that the new methodology could help medical diagnosis (18).

### **Bulgarian contribution in thermographic researches**

E. Stanev and M. Dencheva reported optimization of thermal imaging for evaluation of skin patch test results, that could serve as a safe, accurate and noninvasive method, especially in distinguishing weak positive, doubtful and irritant reactions. They concluded that positive skin reactions appear with much higher temperature than negative reactions in all 22 participants in the survey. The authors confirm that applied IRT could successfully guide the dental practitioner into stepwise removal of bio-incompatible materials from the mouth that cause strong or moderate degree of reaction. (19)

In 2021, R. Grozdanova published an article that discussed two cases in which IRT was successfully used to identify hidden pathological processes. The first patient was 40 years old with alopecia areata and one proven focus of inflammation with dental origin, and the second was a 34 years old with active sinusitis in the left ethmoid sinus. (20)

### **Conclusion**

The use of IRT in dentistry is becoming increasingly common. The method has a few disadvantages, but they don't hinder its application in research and diagnostics. The Bulgarian school of dental clinical allergology has made significant contributions by introducing thermography as an auxiliary method in daily

dental practice. The study of the available scientific literature emphasizes the expanding use of noninvasive methods in dentistry, including thermography.

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