

Thermographic study of the maxillofacial area: the possibilities and prospects in modern dentistry

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ABSTRACT. Thermal pattern of body especially skin can determine the changes in the human body and, the consequences it causes, and changes in normal temperature distribution are a sign of a pathological process. The objective of this essay is to review the possibilities and prospects of Infrared thermography in modern dentistry in order to support dental clinicians to develop and conduct an analysis of maxillofacial changes both the quantitative and qualitative depending on cold acclimation using infrared thermography. Literature were searched in all databases such as PubMed, Medline, and Google Search for articles published between 2019 and 2022. By means of a systematic online database search and based on the PRISMA guidelines related to word infrared thermography, dentistry, inflammation articles were identified using the search engines PubMed, Medline, and Google Scholar. After screening the abstracts and applying the eligibility criteria on those which were fully accessible, 165 articles were included in the review. Amount 145 studies were excluded due to the defined inclusion and exclusion criteria and 20 studies have finally been included in the evaluation process. This was followed by an analysis and discussion of the methodology

KEYWORDS: *Thermography, dentistry, maxillofacial area, Arctic Zone*

INTRODUCTION

Currently, body temperature is one of the most commonly used indicators of health status in humans. Thermal pattern of body especially skin can determine the changes in the human body and, the consequences it causes, and changes in normal temperature distribution are a sign of a pathological process.¹

Physiological and pathological effects of short-term exposure to cold are well known. As known, the human body is physiologically regulated to keep it homeostatic when environmental conditions change. Humans produce or lose heat through thermoregulation to maintain the homeostasis of body temperature and protect themselves against excessive heat or cold. In the same way, environmental temperature may affect physiological responses to exercise through thermoregulation. By contrast, our body promotes heat dissipation by sweat evaporation through increased skin blood vessels when exposed to heat.² Exposure to cold causes various physiological responses in the human

body. It has been reported that cold exposure results in increased heart rate and systolic blood pressure.³ Cold-induced increase in heart rate may be associated with reduced vagal activation compared with sympathetic response to cold.⁴

As research reports have ever been mentioned that during inflammation, where the rate of biochemical processes will decrease but the process of separation of respiration and phosphorylation will increase. As a result, the temperature of the inflamed area will be higher than the temperature of the surrounding tissue.⁵ As is known, changes in normal temperature distribution are a sign of a pathological process.⁶

One of method which working principle is by determining the thermal pattern characteristics is Infrared Thermography. This approach allow us to specify the localization of functional changes, inflammation, and the activity of the process and its prevalence. High information content and reliability of thermal imaging in some diseases is close to

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100%, and in general it is for primary examinations about 80%. Besides, Infrared thermography does not cause discomfort in patients. This technique is completely safe and quite simple in execution. The level of security is very safe, even for more frequent use. This method also allows for use in pregnant women as well as for small children.⁷ In other words, thermal pattern examinations are considered an advancement in popular medical methods. Infrared Thermography also knows as an important adjunctive role in the assessment of dental-oral related illnesses, diseases, and in their clinical diagnosis.⁸ This accurately method possible to examine the entire maxillofacial region.

Meanwhile, an analysis by the Centers for Disease Control and Prevention (CDC) of U.S. temperature-related deaths between 2006 and 2010 showed that 63% were attributable to cold exposure, while only 31% were attributable to heat exposure.⁹ Furthermore, in 2016 number of foreign students' enrolment in Russian Federation are 244,597 students. During the year, the number of students from tropical countries in Russian universities increased by 17%. The number of students from India increased by 20% and from China increased 10%. Ministry of Education of Russian Federation also stated students from Vietnam about 3.1 thousand and from African countries were 11,000 people already received in Russian universities in 2015-2016. Meanwhile, According to World Health

Organization report, it was estimated that around 60-90% of children and 100% adults suffering from dental cavities problem.¹⁰ One of dental problem and most high prevalence rate and difficult to diagnose timely is maxillofacial diseases.¹¹

According to problems above, the temperature is experienced by permanent residences and foreign students as temporary residences in Arctic zone will certainly affect the body's thermal structure, which will eventually show physiological and pathological changes. As we know, Russia Federation is one of the most important arctic zone with temperature interests in the world. Study which explained concerning maxillofacial physiological changes which indicated by cold temperatures using infrared thermography in Arctic Zones using infrared thermography approach still limited. Therefore, it is necessary to conduct study, both qualitatively and quantitatively to analyze maxillofacial physiological changes which indicated by cold temperatures using infrared thermography.

The objective of this essay is to review the possibilities and prospects of Infrared thermography in modern dentistry in order to support dental clinicians to develop and conduct an analysis of maxillofacial changes both the quantitative and quantitative depending on cold acclimation using infrared thermography.

MATERIALS AND METHODS

Literature were searched in all databases such as PubMed, Medline, and Google Search for articles published between 2019 and 2022. By means of a systematic online database search and based on the PRISMA guidelines related to word infrared thermography, dentistry, inflammation articles were identified using the search engines PubMed, Medline, and Google Scholar. After screening the

abstracts and applying the eligibility criteria on those which were fully accessible, 165 articles were included in the review. Amount 145 studies were excluded due to the defined inclusion and exclusion criteria and 20 studies have finally been included in the evaluation process. This was followed by an analysis and discussion of the methodology.

DISCUSSION

Medical infrared thermography is a non-invasive and non-ionizing bidimensional imaging technique that maps the distribution of body surface thermal radiation into images. It is based on the capture and transformation of infrared radiation emitted by the human skin to form images that reflect the local vasomotor response. The mean temperature for the normal condition by using thermography was found $\approx 31^{\circ}\text{C}$ and abnormal condition was $\approx 34^{\circ}\text{C}$. Approximate elevation of 3°C

was observed between the normal and diseased subjects.¹²

Infrared thermography knows as a crucial connected role within the assessment of inflammation.¹³ Inflammation is classically described as a response to infection or injury. It is now increasingly appreciated that chronic inflammation is universally associated with diseases of affluence and extended lifespan such as neurodegenerative diseases and cancer. Other review also stated

response of inflammation triggered by a variety of noxious stimuli and infection.

Thermography is a sensitive clinical diagnostic tool which easy to discover signs of inflammation in a very early, pre-clinical stage, including abnormal condition with no clinical symptoms. Early detection of inflammation could help making treatment more effective and prevent crippling deformation of the joints. One of joint in facial region is Temporomandibular Joints (TMJ). Thermography has found the sites of discomfort varied; in some cases, the symptoms were experienced over and around the masseter muscle and inflammation was reported in the affected region.¹⁴

Meanwhile, the human body is physiologically controlled to preserve homeostatic as soon as environmental circumstances change. Humans manufacture or lose heat through thermoregulation to take care of the equilibrium of vital sign and shield themselves against excessive heat or cold. In cold weather, the body can lose heat faster than it is produced, which uses up stored energy and can lead to hypothermia, defined as a core temperature below 35°C. While, humans have excellent mechanisms to acclimatize to heat, the acclimation capabilities to cold are a topic of controversy. There are different levels of whole body cold acclimation, depending on the degree of the cold exposure. Two levels can be distinguished: 1. Severe cold exposure, leading to a drop in mean skin, tissue and body core temperature generally evoked using repeated cold water immersions, 2. Moderate cold exposure, leading to decrease in skin and tissue temperatures with no or minor drop in body core temperature, generally evoked using repeated cold air exposure. The acclimation capabilities to cold as internal factor may influence the interpretation of the thermal pictures of infrared thermography.¹⁵

One of the external factor that may influence both analysis and interpretation of infrared thermography is environmental factor. There are three main potential factor as environmental sub-factor which in the scope of physiology topic that may influence of infrared thermography approach in Arctic Zones. The following sub-factor are: shivering, hypothermia, and circadian rhythm.

Shivering is uncomfortable for participants especially non-indigenous arctic that could interfere the results of infrared thermography. This factor are very important because many references stated the subject is likely to shiver in lower temperature. Shivering is a protective mechanism by virtue of which heat production occurs, by vigorous

involuntary muscle activity, to compensate for the decreased core temperature in a normal healthy living body. Shivering thermogenesis is main components of cold induced thermogenesis. Within this thermoregulatory continuum, humans are generally well adapted for dissipating heat in warm climates but are particularly maladapted at conserving it in the cold.³

The condition of shivering also possible to provoke hypothermia. Inflammation leads to hyperthermia, whereas degeneration, reduced muscular activity and poor perfusion may cause a hypothermic pattern.¹⁸ As analysis reports have ever been mentioned that in inflammation, wherever the rate of organic chemistry processes can decrease however the method of separation of respiration and phosphorylation can increase. As a result, the temperature of the inflamed area are going to be over the temperature of the surrounding tissue.² As is thought, changes in normal temperature distribution are an indication of a pathological process.

It is important to take into account the circadian rhythm of the human body when conducting an experiment in Arctic Zones. Light of sufficient intensity is the main factor that maintains the 24-h period of human circadian rhythms. Consequently, living in continual daytime or nighttime can causing sleep, mood and productivity problems for people living in Arctic Zones. It has been illustrated that skin temperature varies throughout the day. In the Arctic Zones, people are deprived of natural sunlight in winter and have continuous daylight in summer. Whereas in the evening the core body temperature and proximal skin temperature rise in contrast to distal skin temperature, the opposite effect seems to take place in the morning.¹⁹ Light of sufficient intensity, deprived of natural sunlight in winter, continuous daylight in summer, and prevailing darkness in winter are among the many challenges of making research in the Arctic Zones.

Other research also states, people living in sub-Arctic Zones may experience more seasonal variations in sleep patterns and problems than people living closer to the Equator.²⁰ In many situations during the winter, temporary residents are restricted in movement and causing internal desynchronize of sleep and the circadian system impairs cognitive performance. The change of circadian also related to secretion of hormone melatonin in correlate to short and long daylight. Since there is no evidence could explain the melatonin level in various people either indigenous

or non-indigenous residents in Arctic Zones, melatonin level could depend on ability to adapt to extremes of cold and day length. This clearly suggested that a change in circadian phase both

permanent and temporary residents in Arctic Zones may influence the interpretation of the thermal pictures of infrared thermography.

CONCLUSION

1. The mean temperature for the normal condition by using thermography was found $\approx 31^{\circ}\text{C}$ and abnormal condition was $\approx 34^{\circ}\text{C}$. Approximate elevation of 3°C was observed between the normal and diseased subjects
2. Infrared thermography knows as a crucial connected role to inflammation which easy to discover signs of abnormal condition in a very early, pre-clinical stage such as infection, injury, neurodegenerative diseases and cancer.
3. The acclimation capabilities to cold as internal factor may influence the interpretation of the thermal pictures of infrared thermography
4. One of the external factor that may influence both analysis and interpretation of infrared thermography is environmental factor and three main potential factor as environmental sub-factor are: shivering, hypothermia, and circadian rhythm.

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