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Review Article

Applicability of Infrared Thermography in Dentistry: Mini Review

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Abstract

Infrared thermography is a precise, non-invasive and safe method for measuring superficial temperature, with increasing application in different areas of dentistry, such as endodontics, implantology, restorative dentistry, periodontics, prosthodontics, surgery and principally, for the diagnosis of temporomandibular dysfunction. The aim of this study is to briefly present how thermographic imaging has been used in dentistry. The use of thermography is still restricted in dentistry, but it has great potential for use in daily practice.

Keywords: Thermography; Dentistry; Diagnosis

Mini Review

For centuries, body temperature has been used as a parameter of normality, as well as the relationship between heat and pathological processes. It is directly related to blood flow, regulated by the autonomic nervous system and affects both sides of the body in a uniform and simultaneous manner, producing a symmetrical thermal pattern in the face of normality conditions [1-3] Different disorders can affect blood flow and result in abnormal temperature distribution providing important diagnostic information [4].

It is a sensitive method for measuring the temperature, being a complementary image exam of non-invasive, painless and non-ionizing, which uses infrared radiation emitted by the body. It provides images with precision of spatial resolution, where minimal temperature differences can be evaluated. It provides information in real time of the physiological functions related to thermoregulation, in addition to detecting the extent of functional, nervous and vascular changes, based on the greater or lesser radiance of each region [5,6]. The images obtained through this type of examination can be applied as an auxiliary method in diagnosis, as a form of evaluation in therapeutic interventions or in evolutionary monitoring of pathologies8 in several areas of health, including Dentistry [7].

In dentistry, an instrument of this size has the ability to be very useful to assist in the diagnosis of some functional disorders such as myofacial pain, nerve alterations, herpes labialis in the prodromal phase, periodontal diseases, postoperative evaluation and also as a research tool for evaluation amount of heat transmitted to dental and periodontal tissues during a variety of dental procedures [2-4,7-20]. However, the lack of use protocols, the reduced number of studies and the change in temperature measurement caused by external agents still limit the use of this technique.

Most articles on infrared thermography in the field of dentistry refer to the method as a complementary exam for the diagnosis of temporomandibular disorders and evaluating the effectiveness of various therapies [21-24]. Even though it is the most studied subject, probably because it is a pathological alteration that is difficult to diagnose, the conclusions are not yet unanimous. Several authors have stated that thermography is a useful and promising test in the diagnosis of temporomandibular disorders, however, despite the good diagnostic utility found for thermography, there is still a need for further studies about the subject [1-4,7,9,10-12].

Nerve alterations are common complications in the dental field, whether due to trauma or surgery. Therefore, an examination that is able to diagnose these complications and assess the effectiveness of therapeutic treatment is important. Some authors conducted studies and obtained positive results regarding the effectiveness of thermography in detecting neurological changes in the lower alveolar nerve and others conclude in their studies that infrared thermography has little value in assessing infraorbital nerve deficiency [4,13,25]. The discrepancies in conclusions may arise from the fact that the referred studies do not present standardized methodologies with different cameras and temperatures [4,13,25].

In the field of Periodontics, there are few reports in the literature on the use of infrared thermography. Some studies were used to evaluate the reheating of gingival tissue in patients with periodontal disease and patients with periodontium within normal standards [15,16]. Another study concludes that there is no difference in temperature between the different types of gingival phenotypes [18]. There is a temperature difference between the different gingival regions [16,26]. Studies have obtained similar results, suggesting that infrared thermography can detect static and dynamic temperature differences between healthy gums and inflamed gums [16,26]. Recently, thermography has also been used in some studies as a method of analyzing results when comparing different therapies and surgical techniques [17]. This set of studies indicates the feasibility of further developing the use of this promising and non-invasive method for the evaluation of gingival pathologies and procedures inherent to Periodontics.

In endodontics, *in-vitro* studies have been carried out to evaluate the change in pulp/root temperature during instrumentation and root filling with different materials and as a diagnostic tool for periapical inflammatory lesions [27,31,32].

Analysis of bone temperature changes during drilling of bone tissue for implant installation during the use of osteotomy equipment, maxillary sinus lift, post-operative analysis of surgical procedures has also been carried out using thermographic imaging [33-41].

The use of thermographic imaging has also been studied to evaluate temperature changes after dental caries removal techniques, after light-curing materials with different composite thicknesses after making provisional restorations and finally, analysis of the muscles during mastication [42-45].

In dentistry, the approach by means of infrared thermography has good potential both in the diagnosis of chronic and acute conditions, because, as inflammation generates thermal products, this method is important in the early detection of pathologies [46]. However, due to so many possibilities of interference in the obtention images and the lack of approach to these aspects in the description of several studies, it is necessary that more research be carried out and published, in order to reach a consensus on standardization of technique and reliability of results, enabling the clinical applicability of this method in its totality.

Infrared thermography is a precise, non-invasive and safe method for measuring superficial temperature, with increasing application in different areas of Dentistry. However, it presents some clinical limitations that need to be overcome, for example, the need for a greater number of studies published in the literature and the development of a protocol for use, to standardize the obtaining of thermograms, offering more reliable results that can be compared.

Conflict of Interests

The authors have no conflict of interest to declare.

References

1. Kawano W, Kawazoe T, Tanaka M, Hikida Y. Deep thermometry of temporomandibular joint and masticatory muscle regions. J Prosthet Dent. 1993;69(2):216-21.
2. Canavan D, Gratt BM. Electronic thermography for the assessment of mild and moderate temporomandibular joint dysfunction. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 1995;79(6):778-86.
3. Haddad DS, Brioschi ML, Arita ES. Thermographic and clinical correlation of myofascial trigger points in the masticatory muscles. Dentomaxillofac Radiol. 2012;41(8):621-9.
4. Gratt BM, Anbar M. Thermology and facial tele thermography: Part II. Current and future clinical applications in dentistry.

Dentomaxillofac Radiol. 1998;27(2):68-74.
5. Hildebrandt C, Raschner C, Ammer K. An overview of recent application of medical infrared thermography in sports medicine in Austria. Sensors (Basel). 2010;10(5):4700-15.
6. Christensen J, Vaeth M, Wenzel A. Thermographic imaging of facial skin gender differences and temperature changes over time in healthy subjects. Dentomaxillofac Radiol. 2012;41(8):662-7.
7. Dibai-Filho AV, Packer AC, Costa AC, Rodrigues-Bigaton D. The chronicity of myogenous temporomandibular disorder changes the skin temperature over the anterior temporalis muscle. J Bodyw Mov Ther. 2014;18(3):430-4.
8. Ring EF, Ammer K. Infrared thermal imaging in medicine. Physiol Meas. 2012;33(3):33-46.
9. Weinstein SA, Weinstein G, Weinstein EL, Gelb M. Facial thermography, basis, protocol and clinical value. Cranio. 1991;9(3):201-11.
10. Gratt BM, Sickles EA, Ross JB. Electronic thermography in the assessment of internal derangement of the temporomandibular joint. A pilot study. Oral Surg Oral Med Oral Pathol. 1991;71(3):364-70.
11. Gratt BM, Sickles EA. Thermographic characterization of the asymptomatic temporomandibular joint. J Orofac Pain. 1993;7(1):7-14.
12. Gratt BM, Sickles EA, Wexler CE, Ross JB. Thermographic characterization of internal derangement of the temporomandibular joint. J Orofac Pain. 1994;8(2):197-206.
13. Gratt BM, Shetty V, Saiar M, Sickles EA. Electronic thermography for the assessment of inferior alveolar nerve deficit. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 1995;80(2):153-60.
14. Lamey PJ, Biagioni PA. Thermographic resolution of the prodromal phase of herpes labialis treated with acyclovir. Dentomaxillofac Radiol. 1995;24(3):201-3.
15. Mörmann WH, Bösiger P, Grau P, Scaroni F. The thermodynamic behavior of labial gingiva in patients with destructive periodontal disease. J Clin Periodontol. 1985;12(6):477-93.
16. Barnett ML, Gilman RM, Charles CH, Bartels LL. Computer-based thermal imaging of human gingiva: preliminary investigation. J Periodontol. 1989;60(11):628-33.
17. Silva DF. Gingivectomy with high-power laser for correction of the gummy smile resulting from altered passive eruption—a case series. Lasers Med Sci. 2022;37(7):2999-3009.
18. Bezerra de Melo N, Duarte LNS, Pereira CMV. Thermographic examination of gingival phenotypes: correlation between morphological and thermal parameters. Clin Oral Invest. Ahead of print. 2023.
19. Kurt G, Gül N, Er Ö, Çakmak G, Bendeş E, Aslantaş V. Thermal imaging of the pulp during residual adhesive removal. J Orofac Orthop. 2017;78(4):330-337.
20. Watanabe F, Tawada Y, Komatsu S, Hata Y. Heat distribution in bone during preparation of implant sites: heat analysis by real-time thermography. Int J Oral Maxillofac Implants. 1992;7(2):212-9.
21. Diniz de Lima E, Souza Paulino JA, Lira de Farias Freitas AP, Viana Ferreira JE, Barbosa JDS, Bezerra Silva DF, et al. Artificial intelligence and infrared thermography as auxiliary tools in the diagnosis of temporomandibular disorder. Dentomaxillofac Radiol. 2022;51(2):20210318.
22. Barbosa JS, Amorim A, Arruda M, Medeiros G, Freitas A, Vieira L, et al. Infrared thermography assessment of patients with temporomandibular disorders. Dentomaxillofac Radiol. 2020;49(4):20190392.
23. De Melo DP, Bento PM, Peixoto LR, Martins SKLD, Martins CC. Is infrared thermography effective in the diagnosis of temporomandibular disorders? A systematic review. Oral Surg Oral Med Oral Pathol Oral Radiol. 2019;127(2):185-92.
24. Fikackova H, Ekberg E. Can infrared thermography be a diagnostic tool for arthralgia of the temporomandibular joint? Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2004;98(6):643-50.
25. McGimpsey JG, Vaidya A, Biagioni PA, Lamey PJ. Role of thermography in the assessment of infraorbital nerve injury after malar fractures. Br J Oral Maxillofac Surg. 2000;38(6):581-4.
26. Komoriyama M, Nomoto R, Tanaka R, Hosoya N, Gomi K, Iino F, et al. Application of thermography in dentistry visualization of temperature distribution on oral tissues. Dent Mater J. 2003;22(4):436-43.
27. Suassuna FCM. Thermal and volumetric assessment of endodontic filling techniques using infrared thermography and micro-CT. J Oral Sci. 2023;65(1):34-9.
28. Viapiana R, Baluci CA, Tanomaru-Filho M, Camilleri J. Investigation of chemical changes in sealers during application of the warm vertical compaction technique. Int Endod J. 2015;48(1):16-27.
29. Diegritz C, Gerlitzki O, Fotiadou C, Folwaczny M. Temperature changes on the root surface during application of warm vertical compaction using three different obturation units. Odontol. 2020;108(3):358-65.
30. Briseño Marroquín B, Wolf TG, Schürger D, Willershausen B. Thermoplastic properties of endodontic gutta-percha: a thermographic *in-vitro* study. J Endod. 2015;41(1):79-82.
31. Ulusoy ÖI, Yılmazoğlu MZ, Görgül G. Effect of several thermoplastic canal filling techniques on surface temperature rise on roots with simulated internal resorption cavities: an infrared thermographic analysis. Int Endod J. 2015;48(2):171-6.
32. Aboushady MA, Talaat W, Hamdoon Z, M Elshazly T, Ragy N, Bourauel C, et al. Thermography as a non-ionizing quantitative tool for diagnosing periapical inflammatory lesions. BMC Oral Health. 2021;21(1):260.

33. Harder S, Egert C, Freitag-Wolf S, Mehl C, Kern M. Intraosseous temperature changes during implant site preparation: *in-vitro* comparison of thermocouples and infrared thermography. Int J Oral Maxillofac Implants. 2018;33(1):72-8.
34. Möhlhenrich SC, Modabber A, Steiner T, Mitchell DA, Hölzle F. Heat generation and drill wear during dental implant site preparation: systematic review. Br J Oral Maxillofac Surg. 2015;53(8):679-89.
35. Möhlhenrich SC, Abouridouane M, Heussen N, Hölzle F, Klocke F, Modabber A. Thermal evaluation by infrared measurement of implant site preparation between single and gradual drilling in artificial bone blocks of different densities. Int J Oral Maxillofac Surg. 2016;45(11):1478-84.
36. Möhlhenrich SC, Abouridouane M, Heussen N, Modabber A, Klocke F, Hölzle F. Influence of bone density and implant drill diameter on the resulting axial force and temperature development in implant burs and artificial bone: an *in-vitro* study. Oral Maxillofac Surg. 2016;20(2):135-42.
37. Gabrić D, Aumiler D, Vuletić M, Gjorgievska E, Blašković M, Mladenov M, et al. Thermal Evaluation by Infrared Thermography Measurement of Osteotomies Performed with Er:YAG Laser, Piezo surgery and Surgical Drill-An Animal Study. Materials (Basel). 2021;14(11):3051.
38. Scarano A, Lorusso F, Arcangelo M, D'Arcangelo C, Celletti R, de Oliveira PS. Lateral sinus floor elevation performed with trapezoidal and modified triangular flap designs: a randomized pilot study of post-operative pain using thermal infrared imaging. Int J Environ Res Public Health. 2018;15(6):1277.
39. De Carvalho GR, Rodrigues WN, Barboza JVM, Nery CG, Moreira FDCL, Roriz VM. Infrared thermography in the evaluation of dental socket healing after photobiomodulation therapy: a case report. J Lasers Med Sci. 2021;12:e11.
40. Pedreira AA, Wanderley FG, Sa MF, Viena CS, Perez A, Hoshi R, et al. Thermographic and clinical evaluation of 808-nm laser photobiomodulation effects after third molar extraction. Minerva Stomatol. 2016;65(4):213-22.
41. Kolosovas-Machuca ES, Martínez-Jiménez MA, Ramírez-GarcíaLuna JL, González FJ, Pozos-Guillen AJ, Campos-Lara NP, et al. Pain measurement through temperature changes in children undergoing dental extractions. Pain Res Manag. 2016;2016:4372617.
42. Baraba A, Kqiku L, Gabrić D, Verzak Ž, Hanscho K, Miletić I. Efficacy of removal of cariogenic bacteria and carious dentin by ablation using different modes of Er:YAG lasers. Braz J Med Biol Res. 2018;51(3):e6872.
43. Bakhsh TA, Alfaifi A, Alghamdi Y, Nassar M, Abuljadyel RA. Thermal sensing of photo-activated dental resin composites using infrared thermography. Polymers (Basel). 2023;15(20):4117.
44. Lipski M, Woźniak K, Szyszka-Sommerfeld L, Borawski M, Droździk A, Nowicka A. *In-vitro* infrared thermographic assessment of temperature change in the pulp chamber during provisionalization: effect of remaining dentin thickness. J Healthc Eng. 2020;2020:8838329.
45. Salles PV, Valentim AF, Haddad DS, Furlan RMMM, Gama ACC, Motta AR. Proposal of a protocol for thermographic assessment of the orbicularis oris muscle. J Oral Rehabil. 2022;49(12):1181-7.
46. Nasution AI, Pankov MN. The advantage and basic approach of infrared thermography in dentistry. J Int Dent Med Res. 2020; 13(2):731-7.