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Is Infrared Thermography an effective tool for identifying the anatomical site of orofacial pain?

Whole-body thermographic assessment of patients with stroke sequelae who report temperature differences between the sides

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Contents

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Prof DDr. Kurt Ammer
European Association of Thermology (EAT)
Hernalser Hauptstr.204/14 A-1170 Wien, Österreich
Phone &:Fax (43 1) 480 54 23 :
email:KAmmer1950@aol.com

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CONSORT-(CONsolidated Standards Of Reporting Trials) for randomised controlled trials with parallel group design [2]

STROBE (STrengthening the Reporting of OBservational Studies in Epidemiology) for case control, cohort and crosssectional studies [3]

PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) for systematic reviews and meta-analysis [4]

STARD (STAndards for Reporting of Diagnostic accuracy) for diagnostic tests [5]

CARE (Consensus-based Clinical CAse Reporting Guideline Development) for case or care reports [6]

SPIRIT (Standard Protocol Items: Recommendations for Interventional Trials) for study protocols [7]
SAMPL(Statistical Analysis and Methods in the Published Literature) for statistical reporting. [8]

The TISEM checklist is strongly recommended as guideline for complete reporting of thermographic studies [9]

In general, manuscripts hould be organized as follows: Introduction, methods, results, discussion, acknowledgements, references. A short abstract in English and, if possible, German (translation will be offered) should head the manuscript. Following the abstract, up to 5 key-words should characterize the paper.

Tables, Figures and Legends for illustrations should appear each on an extra sheet of paper.

References should be numbered consecutively in the order in which they are first mentioned in the text. Identify references in text, tables, and legends by Arabic numerals in parentheses.Use the style of the examples below which are based on the formats used by the US National Library of Medicine in Index Medicus (complete list of examples on [1]).

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Luther B, Kreyer I, Dobi I. Die Anus-praeter-Thermographie als Methode zur Früherkennung vaskulärer Komplikationen nach Dünndarmtransplantation. ThermoMed 1990; 6: 115-7.

Chapter in a book
Gautherie M, HaehnelP, Walter JM, Keith L. Long-Term assessment of Breast Cancer Risk by Liquid Crystal Thermal Imaging. In: Gautherie M, Albert E, editors. Biomedical Thermology. New York Alan R.Liss Publ; 1982. p. 279-301.

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References:

[1] International Committee of Medical Journal Editors. Uniform requirements for manuscripts submitted to biomedical journals. Medical Education 1999; 33; 066-078

[2] www.consort-statement.org

[3]www.strobe-statement.org

[4]www.prisma-statement.org

[5] www.stard-statement.org

[6] www.care-statement.org

[7] www.spirit-statement.org

[8]www.equator-network.org/wp-content/uploads/2013/03/SAMPL-Guidelines-3-1

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Is Infrared Thermography an effective tool for identifying the anatomical site of orofacial pain? A systematic review

Isabella Stagliorio Dumet Faria[1], Fernanda Christina de Carvalho[2], Márcia Maria Peixoto Leite[3], Juliana Borges de Lima Dantas[4], Silvia Regina de Almeida Reis[5]Alena Ribeiro Alves Peixoto Medrado[6]

[1]Student of the Dentistry Course, Bahiana School of Medicine and Public Health Salvador, Bahia, Brazil.
[2] Post-graduated student of Medicine and Human Health, Bahiana School of Medicine and Public Health Salvador, Bahia, Brazil.
[3] Health Sciences Institute, Federal University of Bahia, Salvador, Brazil
[4] Assistent Teacher of the Dentistry Course, Bahiana School of Medicine and Public Health and Graduate Program in Interactive Processes of Organs and Systems, Health Sciences Institute, Federal University of Bahia, Salvador, Brazil
[5] Adjunct Teacher of the Dentistry Course, Bahiana School of Medicine and Public Health Salvador, Bahia, Brazil.
[6]Adjunct Teacher of the Dentistry Course, Ph.D in Human Pathology, Bahiana School of Medicine and Public Health Salvador, Bahia, Brazil.

SUMMARY

Infrared thermography (IRT) is a painless and non-invasive diagnostic tool that captures the surface temperature distribution of the patient and enables identification of the likely anatomical site of pain. This study aimed to investigate the potential of IRT for identifying the anatomical site related to orofacial pain. This systematic review research included randomized and non-randomized prospective studies published in PubMed, Cochrane, Scielo databases, and Google Scholar. The review was conducted according to PRISMA guidelines. Of the 9,358 articles found, only seven met the inclusion criteria, with a total population of 626 patients. It was noted that the selected studies showed diagnostic potential of IRT, particularly when this technique was related to physical examination in patients reporting dentoalveolar abscesses, facial fractures and orofacial pain. Thus, IRT proved to have diagnostic potential, but further studies are still needed to standardize the interpretation parameters of this diagnostic method for orofacial pain.

KEYWORDS: Orofacial pain, Infrared Thermography, Dentoalveolar abscess, Facial fracture.

IST DIE INFRAROT-THERMOGRAFIE FÜR DIE ENTDECKUNG DES ANATOMISCHEN URSPRUNGS OROFAZIALER SCHMERZEN GEEIGNET? EIN SYSTEMATISCHER REVIEW

Die Infarot-Thermografie ist ein schmerzloses, nicht invasives diagnostisches Hilfsmittel, das das die Oberflächentemperaturverteilung des Patienten erfasst und die Identifizierung der wahrscheinlichen anatomischen Schmerzstelle ermöglicht. Diese Studie zielte darauf ab, das Potential von IRT zur Identifizierung der anatomischen Stelle im Zusammenhang mit orofazialen Schmerzen zu untersuchen. Diese systematische Übersichtsarbeit umfasst randomisierte und nicht randomisierte prospektive Studien, die in PubMed, Cochrane, Scielo-Datenbanken und Google Scholar veröffentlicht wurden. Die Überprüfung wurde gemäß den PRISMA-Richtlinien durchgeführt. Von den 9.358 gefundenen Artikeln erfüllten nur sieben die Einschlusskriterien mit einer Gesamtpopulation von 626 Patienten. Es wurde festgestellt, dass die ausgewählten Studien diagnostisches Potential von IRT zeigten, inbesonders, wenn diese Technik bei Patienten, die über dento-alveoläre Abszesse, Gesichtsfrakturen und orofaziale Schmerzen berichteten, mit der körperlichen Untersuchung in Beziehung gebracht wurde. Damit hat sich die IRT als diagnostisch erwiesen, jedoch sind weitere Studien notwendig, um die Interpretationsparameter dieser diagnostischen Methode für den orofazialen Schmerz zu standardisieren.

SCHLÜSSELWÖRTER: Orofazialer Schmerz, Infrarot-Thermografie, Dentoalveolarer Abszess, Gesichtsfraktur.

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Introduction

The most common emergencies in Dentistry are pulpitis, dentoalveolar abscess, pericoronitis, temporomandibular dysfunction (TMD), and tooth fracture. In general, patients seek a dental service unit with the complaint of pain/discomfort but usually can't identify the exact location of the pain phenomenon (1).

Taking pulpitis as an example, one must consider the physical involvement of the pulp by hard tissues and the structural changes of the pulp with age (2). It is important to emphasize that pulp inflammation is hampered by its small volume and the fact that it is surrounded by dentin. Classically, it's accepted that in dental cavity, pulpal inflammation is initiated by a low-grade chronic response and its progress results in an acute process that overlaps with the chronic elements (3). The inflammatory reaction can increase pulpal temperature, and its early detection through more accurate diagnostic methods is necessary. In this sense, the use of infrared thermography (IRT) has stood out in Dentistry, not only for detecting pain of dental origin but also of any other facial anatomicals sites. The local increase and/or facial thermal gradient, can also be observed in inflammatory processes of an infectious nature such as abscesses and pericoronitis, given that in these dysfunctions, the vascular changes resulting from acute inflammation are represented mainly by vasodilation and increased vascular permeability (4).

It is known that the inflammatory process is characterized by the production and emission of heat resulting from the vasodilation of tiny blood capillaries (5). Therefore, using a diagnostic method that allows capturing the thermal differences at the anatomicals sites where the inflammatory reaction is ongoing would allow identifying significant vascular disorders and the likely origin of pain in tissues affected by this biological process.

Recently, this analysis has been increasingly performed using IRT (6). The use of IRT by dental surgeons and other health professionals in diagnosing lesions of inflammatory nature that occur in the face and oral cavity has been reported in the literature. It is important to highlight that most of the studies that have been published analyzed the effectiveness of IRT in the diagnosis of temporo-man dibular disorders. For example, two systematics reviews had already discussed the use of IRT to diagnose these pathologic conditions (7, 8). Other studies have investigated IRT as a viable modality for early screening of oral cancer and an efficient tool able to register self-reported facial affective states of individuals, facial skin temperature and discomfort when wearing protective face masks, quantitative assessment of Bell's palsy-related facial thermal asymmetry and to identify myofascial trigger points (MTPs) in the masticatory muscles (9-12). However, the use of IRT as an alternative tool for the diagnosis of other buco-maxillofacial conditions still needs to be further explored.

As a matter of fact, with a high-performance camera, it is possible to locate the trigger points of various types of orofacial pain and identify anatomicals sites with evident loss of functionality, without any risk to the patient as the site of pain/discomfort of the patient can be located through the change in temperature resulting from the dysfunction (1, 5). In consequence, this procedure contributes to a more accurate and less invasive clinical examination, especially in Dentistry. Furthermore, the site of pain/discomfort of the patient can be located through the change in temperature resulting from the dysfunction (1).

This systematic review aimed to evaluate the effectiveness of infrared IRT as an auxiliary diagnostic method for identifying the anatomical sites compromised by pain arising from inflammatory conditions.

Methods

Protocol and Record

This systematic review was conducted according to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) methodology. This review was submitted to the PROSPERO platform and registered under protocol number CRD 42021226741.

Eligibility Criteria

Inclusion criteria encompassed articles in Portuguese and English, online, and classified as retrospective and prospective studies, including randomized or non-randomized clinical trials, published in the last ten years, from 2010 to 2020. In addition, only studies with patients with diagnosis of orofacial pain, dentoalveolar abscess, facial fracture, and pulpitis and in which IRT was used to diagnose pain.

The research question was "**Is Infrared Thermography an effective tool for identifying the anatomical site of orofacial pain**?" The construction was performed from the PICO anagram in which the population (P) was represented by patients who presented orofacial pain and/or dentoalveolar abscess and/or facial fracture; the Intervention (I) consisted in the use of the infrared thermography camera (IRT) for the diagnosis of the specified clinical pictures; The Comparator (C) was other diagnostic method rather than IRT, and the outcome (O) was the performance of IRT in identifying the anatomical site that generated pain/discomfort in the patient.

Search strategy

Scientific articles available in electronic databases such as PubMed /Medline, Scielo, and Cochrane. Some manuscripts of Google Scholar were included as gray literature. Studies were selected from May 2020 to February 2021. The following keywords indexed in DeCS/MeSH were used as descriptors of the literature search: "orofacial pain," "infrared thermography," "dentoalveolar abscess," "facial fracture".In addition, the uniterms were associated with Boolean expressions AND/OR in order to form different combinations, namely "orofacial pain" OR "dentoalveolar abscess" OR "facial fracture" AND "Infrared thermography" OR "thermal imaging" OR "infrared imaging" OR "IRT" AND "sensitivity" OR "specificity" OR "predictive value" OR "likelihood ratio". Such combinations were used in all databases and in the Google Scholar in the same way.

Study Selection and Data Extraction

Articles were selected by analyzing the title, abstract, and full text, based on the previously criteria. Duplicate articles were considered only once. Two examiners (IF and AM) performed the selection independently, and data extraction. In case of a disagreement between them, a third author would be requested (JD), which was not necessary. Data were extracted using the inclusion/exclusion criteria and according to detailed methodology, and presence of results. Manuscript information about the year, authors, study type, population, results, and the conclusion was entered into a descriptive table.

Methodological Quality and Risk of Bias

The QUADAS 2 system was used to evaluate the risk of bias and applicability of diagnostic accuracy studies, with two key domains (risk of bias and applicability concerns).

Results

In the first stage of the literature search, 9,358 articles found in the electronic databases were identified distributed as follows, one was found from references of another article, none in Scielo, 21 in PubMed, 1 in Cochrane, and 9,336 in Google Scholar. Thus, 8,875 articles were excluded in the first step, after reading the titles and removing duplicate manuscripts. Of the remaining 482 manuscripts, 475 were excluded after reading the abstracts because they were clinical case reports and literature reviews or did not correlate with orofacial pain diagnosed by IRT. Thus, seven studies were selected in the eligibility stage for full-text reading. Flowchart 1 illustrates the search strategy.

The sample size varied depending on the type of study, and the total number of participants was 626 individuals. Among the seven selected studies, five addressed orofacial pain (5, 13-16), one analyzed dentoalveolar abscess (17) and one evaluated abscesses and and facial fracture (18) (Table 1).

The QUADAS 2 system was used in two accuracy studies (17, 18) and demonstrated a low risk of bias in both studies and adequate applicability to the research question, as shown in Chart 1.

Overall, the three studies that exclusively evaluated orofacial pain comprised clinical trials covering the postoperative period of third molar surgeries. Batinjan et al. (2014) (13) and Dostalova et al. (2017) (15) analyzed 40 and 218 patients, respectively, intending to observe, through IRT, the effect of laser photobiomodulation on the degree of pain and inflammation related to surgical removal of lower third molars. In both studies, patients were allocated into two groups, one of which was subjected to 830 nm laser

Flowchart 1-
Manuscript's search strategy, according to the outlined inclusion criteria. Search period: May 2020 to February 2021.

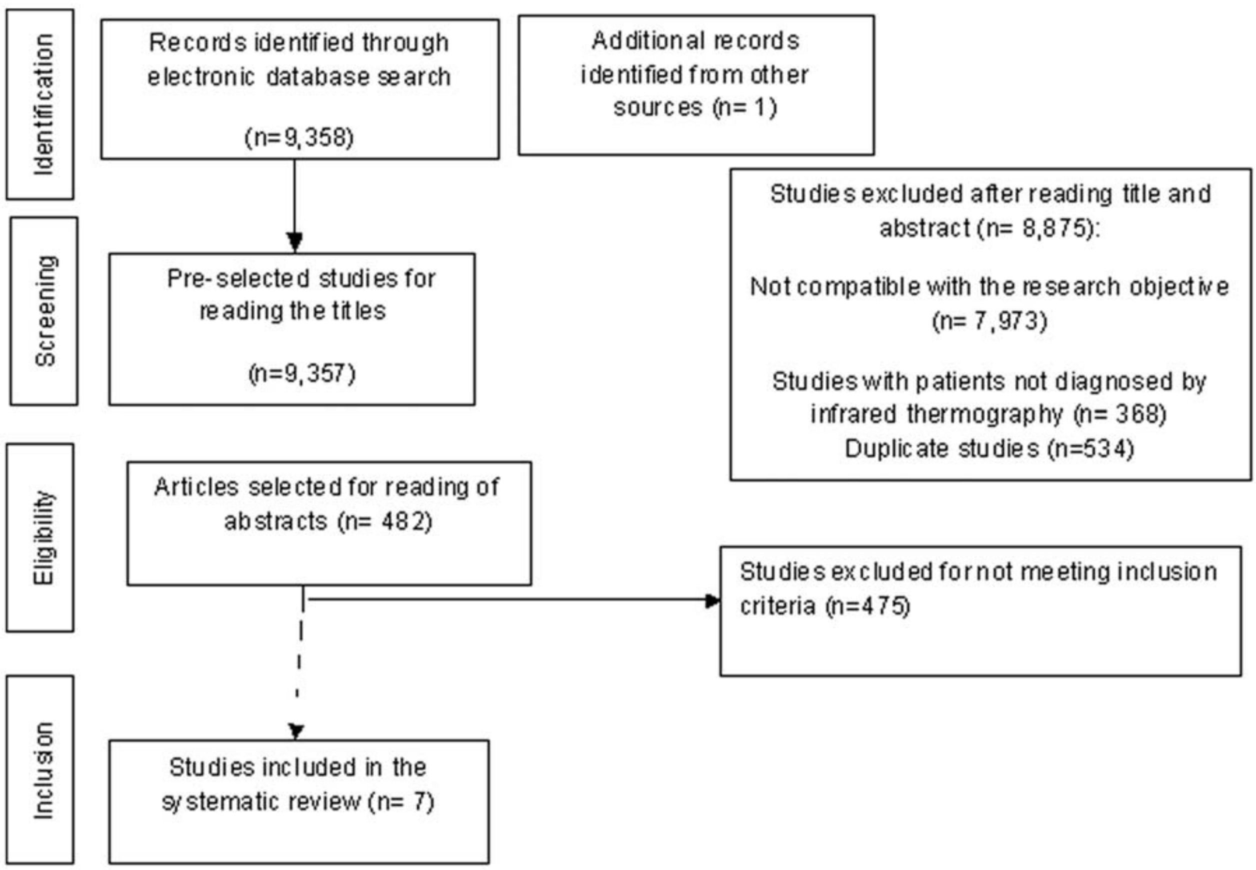

Table 2.
QUADAS 2 quality assessment for accuracy studies.

Author (Year)	Risk of bias				Applicability concerns		
	Patient selection	Index test	Reference standard	Flow and timing	Patient selection	Index test	Reference standard
Durnovo et al., 2014 (17)	L	L	L	L	L	L	L
Mohammed Ammoush et al., 2018 (18)	L	L	L	L	L	L	L

Legend: L = low; H = high; U = unclear.

Table1.
Summary of selected manuscripts. Search period: June to September 2020. Salvador, Bahia, Brazil.

Title	Authors (year)/ Journal	Objective	Methods	Results	Conclusion
Thermographic and clinical correlation of myofascial trigger points in the masticatory muscles	Haddad et al., 2012 (5) Dentomaxillofacial Radiology	Identify and correlate myofascial pain points (MTPs) in masticatory muscles using thermography and algometry.	Twenty-six female (n=26) were recruited. The facial surface area over the masseter and anterior temporalis muscles was divided into 15 subareas on each side. The investigation consisted of three stages. The first step involved the investigation of facial thermographic examination using lateral views. The second step involved pressure pain thresholding (PPT), marking the MTP pattern areas for referred pain and local pain with a crayon, and a photograph of the lateral face with the head in the same position as the infrared image. The last step was to merge these two images, using dedicated software (ReporterH 8.5-SP3 Professional Edition and QuickReportH 1.2, FLIR Systems, Wilsonville, OR); and calculating the temperature of each point.	Of the entire sample of 395 MTPs, physical examination results characterized 264 as local pain points, consisting of 74 (18.7%) anterior temporal and 190 (48.1%) masseter muscles, and 131 were referred pain points, consisting of 35 (8.9%) anterior temporal and 96 (24.3%) masseter muscles. When the right and left hemifacial images were compared, no thermal predominance was found for either side ($p = 0.05$). The temporalis muscle showed a higher temperature than the masseter muscle for all subjects ($p < 0.05$).	Thermograms were useful, being a non-invasive, non-ionizing examination method for diagnosing MTPs in masticatory muscles.

Title	Authors (year)/ Journal	Objective	Methods	Results	Conclusion
Thermographic and clinical evaluation of 808-nm laser photobiomodulation effects after thid molar extraction	Pedreira et al., 2015 (14) Edizioni Minerva Medica	To evaluate the effectiveness of the 808 nm aluminum gallium arsenide (AlGaAs) laser after third molar extraction using the infrared thermography technique.	The patients (n=24) were divided into four groups: erupted third molars were extracted from patients in Groups I and II, and impacted third molars were extracted from patients in Groups III and IV. Groups I and III received simulated laser therapy in which the device was turned off, and Groups II and IV were exposed to laser light. Postoperative clinical parameters related to third molar extraction such as pain, trismus, and edema were evaluated. Circulatory patterns were also evaluated by infrared thermography that displayed local temperature coefficient at different postoperative periods.	A slight improvement in edema and pain was observed in patients who received laser irradiation, although the differences were not statistically significant ($p>0.05$). Laser therapy had a significant influence on local circulation in the area near the temporomandibular joint, as determined by infrared thermography ($p<0.05$).	Lasertherapy was able to alter local circulation, although it did not significantly influence edema, pain, or trismus during the postoperative period.
Low-Level Laser Therapy After Wisdom Teeth Surgery: Evaluation of Immunologic Markers (Secretory Immunoglobulin A and Lysozyme Levels) and Thermographic Examination: Placebo Controlled Study	Dostalova et al., 2017 (15) Photomedicine and Laser Surgery	To analyze the effect of Laser Photobiomodulation (LLLT) on the degree of pain and inflammation related to surgical removal of mandibular third molars using immunological markers and infrared thermography.	(n=218) The study groups included laser (830 nm diode) and placebo. The efficacy of laser therapy was evaluated based on immunological tests, i.e. before and after treatment, using sIgA and lysozyme in unstimulated saliva and infrared thermography.	A relationship was found between individual salivary sIgA concentration and the action of photobiomodulation. After the use of photobiomodulation the levels of sIgA decreased from 546.91 mg/L to 304.91 mg/L, while in the control group it decreased from 602.25 mg/L to 425.62 mg/L ($p<0.05$). Thermographic analysis did not show significant thermal variations $p>0.05$).	A significant positive correlation was found between salivary sIgA concentration and the action of laser photobiomodulation. Bone tissue lesions after 3rd molar extraction did not compromise the pattern of variation of thermal coefficient measured by infrared thermography. The bone tissue lesions after third molar extraction did not compromise the variation pattern of the thermal coefficient measured by infrared thermography.

Title	Authors (year)/ Journal	Objective	Methods	Results	Conclusion
Diagnostic capabilities of Infrared thermography in the examination of patients with diseases of maxillofacial area	Durnovo et al., 2014 (17) Sovremennye Tehnologii v Medicine	To evaluate the accuracy of infrared thermography as a diagnostic method for maxillofacial pathological conditions.	Patients (n=250) with different pathological maxillofacial conditions underwent a clinical examination and thermographic analysis. All patients were divided into three groups: group 1 (n=114) - patients with inflammatory diseases of the maxillofacial area; group 2 (n=40) - patients with traumatic maxillofacial injuries; group 3 (n=96) - patients with benign (n=54) and malignant (n=42) neoplasms of the maxillofacial area.	Local temperature indices of the maxillofacial area were found to change significantly in inflammatory diseases. The decrease of temperature indices was revealed in the center of root cysts (0.1-0.3°Ñ), in central and peripheral points (1.3-2.3°Ñ) on chronic osteomyelitis, in acute purulent periostitis (1. 2-1.9°Ñ), in acute osteomyelitis (1.5-1.9°Ñ), in acute abscess (2.0-2.3°Ñ), in odontogenic phlegmon of the maxillofacial area (1.4-3.0°Ñ), and in odontogenic abscess (1.8-2.4°Ñ). There was a significant increase in temperature indices in traumatic injuries: in LeFort fractures (1.3-1.5°Ñ) and in mandibular fractures (0.2-0.6°Ñ). A significant increase in temperature indices was observed in malignant neoplasms(2.8-3.6°Ñ), whereas temperature indices on benign tumors did not exceed 1.4°C.	Infrared thermography was a reliable, highly informative, non-invasive and safe method that did not require trained personnel. It can be used for initial diagnosis, differential diagnosis, and prognostic studies in various diseases of the maxillofacial area.
Clinical evaluation of thermography as a diagnostic tool in oral and maxillo-facial lesions	Mohammed Ammoush et al., 2018 (18)	To evaluate the use of thermography in the diagnosis of dental abscesses and cellulitis of odontogenic origin, and to determine whether the changes in heat emitted by a dental abscess and cellulitis are different.	A total of 48 adult patients seen in the Department of Conservative Dentistry at Royal Medical Services suspected of having facial cellulitis or a dental abscess. Thermal images of affected and unaffected skin were obtained for each patient. A provisional diagnosis was made based on clinical examination, isolated and clinical examination plus thermography, and a definitive diagnosis of abscess was made when the incision for drainage revealed the presence of pus. The temperature difference was calculated between the affected site and the corresponding contralateral regions.	A correct diagnosis was made 87.5% of the time using clinical examination alone, while clinical examination with thermography increased the correct diagnosis to 95.8% of cases. There were no significant temperature differences between the affected site and the contralateral unaffected site in facial cellulitis and dental abscess patients were recorded (2.1 versus 1.68 °C, p =0.4930). Temperature differences were greater in patients with facial cellulitis than in patients with dental abscess, and in particular, in women (2.84 versus 0.92 °C, p =0.0016). Temperature differences between contralateral affected and unaffected sites were greater in patients with facial cellulitis (2.4 °C) than in patients with dental abscess (1.49 °C) (p = 0.0485).	Thermography can be used as an adjunct to make a correct and differentiating diagnosis between facial cellulite and dental cellulite.

Title	Authors (year)/ Journal	Objective	Methods	Results	Conclusion
Thermographic monitoring of wound healing and oral health related quality of life in patients treated with laser (aPDT) afterimpacted mandibular third molar removal	Batinjan et al., 2014 (9) Int. J. Oral Maxillofac. Surg.	To evaluate the impact of laser photobiomodulation on edema, temperature changes, and oral health-related quality of life (OHRQoL) following surgical removal of impacted mandibular third molars.	Forty patients (n=40) with impacted mandibular third molars that required surgical removal participated in this study. One group received photodynamic therapy (aPDT) and the other did not receive any additional therapy. Temperature measurement was performed on days 3 and 7 of the postoperative period. The OHRQoL was applied to both groups on day 7.	There was no significant temperature difference between the aPDT group and the placebo group before the procedure. Both groups had almost the same temperature in the impacted lower third molar region (p=0.76). The aPDT group had significantly more participants with edema in the wound area on day 3 compared to the placebo group, which had a greater number of individuals with moderate and severe edema ($p < 0.001$). On postoperative day 7, there was no significant difference in the degree of edema between the groups ($p = 0.826$). The temperature 3 days after removal of the lower third molar was 35.35°C, and the temperature of the control group was 36.29°C. On day 7, the laser group had 35.02°C and the control group 35.45°C ($p>0.05$).	The authors demonstrated beneficial effects of phototherapy on edema, with a decrease in the thermal coefficient. The application of the OHRQoL showed a better degree of quality of life in the 7-day postoperative period compared to the placebo group.
Thermography and oral pathology	Mostovoy, 2012 (13) EAT2012 Book of Proceedings – Appendix 1 of Thermology international 22/3 (2012)	To illustrate the use of thermography in the identification of asymptomatic patients patients with oral pathology of dental origin.	The population consisted of 20 patients (2 men and 18 women, aged 42 to 63 years) who visited the Thermography Clinic in Toronto, Ontario, Canada with varying complaints. All patients were evaluated with IR imaging and followed up with dental examinations that included x-rays and examination of the oral cavity. Patients were followed up with additional clinical examinations for up to one year. Patients were evaluated with the FLIR A-320 infrared thermography camera, and examination guidelines were followed as established by the International Academy of Clinical Thermology.	A total of 14 patients (70%) had no symptoms related to dental pathology. The number of oral cavity findings („spots") per patient ranged from 1 to 4 (mean ± SD is 2.1 ± 1.1). Most patients had 1 (40%) or 2 (30%) dental cavity. Following the thermographic evaluation, 8 subjects (40%) had a follow-up dental examination in less than a month, 12 subjects (40%) had such an examination in 1-2 months. Ten subjects (50%) subsequently had another dental exam, 7 subjects saw the dentist within 6 months. In 11 subjects, (55%), thermographic were performed during the 1st follow-up dental examination. In 14 subjects with 1-2 detected points, 6 subjects (42.9%) had confirmed results. Five out of 6 subjects (83.3%) with 3-4 points received such confirmation. During the 2nd follow-up thermographic dental, results were confirmed in all 10 subjects evaluated. Notably, in 7 of these, the results of the first examination were confirmed. The dental evaluations were not confirmatory. When both the 1st and 2nd dental evaluations are taken into account, thermographic results confirmed at least once in every 18 of our 20 subjects.	The IR imaging procedure provided information about physiological processes by examining the temperature of the face area that can be related to the internal process of inflammation or irritation. The early signs provided by IR imaging can be used as prognostic indicators in the detection of oral and or dental pathology. Non-invasive IR imaging allowed the identification of early stages of inflammation not visible by other imaging modalities. The high confirmation rate (90%) indicates a strong correlation between thermography and dental examinations.

photobiomodulation, and in control, no laser light was emitted. In the study by Batinjan et al. (2014) (13), anti-microbial photodynamic therapy (PDT) was performed with the same photobiomodulation parameters. The authors reported decreased thermal gradient in the groups subjected to photobiomodulation compared to controls. In addition, significantly lower temperature and less edema were recorded in the wound area on postoperative day 3 in the PDT group compared to the control group.

Additionally, Pedreira et al. (2016) (14) analyzed the post-operative period of patients who underwent surgery for already erupted and impacted third molars using IRT to identify anatomical sites of pain. The authors reported no statistically significant differences in the thermal gradient measured in different periods concerning the study variables, including edema, trismus, and pain.

Durnovo et al. (2014) (17), in their case-control study, analyzed 250 patients with lesions of the bucomaxilofacial complex, which included abscesses and fractures, using IRT and observed a significant increase in the thermal gradient associated with these lesions. Mostovoy et al.(2012) (16) analyzed 20 patients to demonstrate the use of IRT to diagnose lesions of dental origin in asymptomatic individuals and found that six patients (30%) had thermal changes suggestive of odontalgia. The use of this techinique provided the acquisition of information about the temperature of the face. This area could be related to internal processes of inflammation of the pulp or oral mucosa. The authors concluded that thermogram acquisition was important for identifying early stages of inflammation not noticeable by other diagnostic imaging methods and reported a positive correlation between changes in facial thermal coefficients and intraoral physical examination findings.

Mohammed Ammoush et al.(18) analyzed 48 patients diagnosed with dentoalveolar abscesses and cellulitis of odontogenic origin using IRT. Such authors detected that participants showed a temperature increase on the order of 1.68 to 2.1°C at the anatomical site evaluated, although without statistical significance. Durnovo et al. (2014) (17) demonstrated that IRT helped determine the thermal differential in abscesses, which ranged from 1.8-2.4°C.

In the study by Haddad et al. (2012) (5), 26 patients were recruited to identify and correlate myofascial pain points (MTPs) in the masticatory muscles using IRT and algometry. Pressure pain threshold (PPT) levels measured at referred MTP pain points (1.28±0.45 kg) were significantly lower than local MTP pain points (1.73±0.59 kg; $p<0.05$). In addition, thermograms indicated differences between referred and site pain in MTPs of 0.5 °C ($p<0.05$). Sensitivity and specificity on MTPs were 62.5% and 71.3%, respectively, for referred pain, and 43.6% and 60.6%, respectively, for indicated site pain.

Discussion

This systematic review aimed to evaluate the effectiveness of IRT as an additional method for identifying orofacial pain. IRT is a noninvasive, non-ionizing diagnostic imaging modality capable of demonstrating cutaneous vasomotor neurovegetative activity that has been increasingly used in Dentistry (3). Its image formation principle is based on the capture and transformation of infrared radiation emitted by human body into images that reflect the microcirculatory dynamics of the skin surface (19).

The diagnosis of orofacial pain is complex as it depends on an individual, subjective and unique perception of the pain experienced by the patient. The use of more objective diagnostic methods, such as thermograms, can contribute to the elucidation of the location and etiology of the pain phenomenon (15). During the systematized search of studies that considered IRT for the diagnosis of orofacial pain, it was observed that its most significant indication was for the diagnosis of TMD. Studies such as those conducted by Batinjan et al. (2014) (13), Pedreira et al. (2016) (14) and Dostalova et al. (2017) (15), demonstrated the effectiveness of IRT in this clinical condition usually identified in dental practice.

Of the seven studies included in this review, it was found that 3 (42.8%) used IRT as a complementary diagnostic method exclusively for orofacial pain of undetermined etiology. In this context, the thermal imaging pattern described by Batinjan et al. (2014) (13), Pedreira et al. (2016) (14) and Dostalova et al. (2017) (15), consisted of hyper-radiating areas with evident temperature increase, being a solid indication of the pain of inflammatory origin. Furthermore, in some ROIs (regions of interest), the thermal coefficient even varied above 0.3ºC, which is considered a significant abnormality according to the criteria of Haddad et al. (2012) (5). Therefore, IRT should be recommended and correlated with the patient's clinical evaluation to determine the diagnosis of orofacial pain.

IRT can be used by endodontists and clinical dentists for routine complementary diagnosis of the pain of dental origin. Also, in this respect, Mohammed Ammoush et al. (2018) (18) used IRT to determine the site of dentoalveolar abscesses and found that the correct diagnosis was made in 87.5% of the evaluated cases, while when the clinical examination was performed in association with IRT, the diagnostic efficacy increased to 95.8% of the cases. Furthermore, the most significant temperature differences were noticed in patients with facial cellulitis compared to a dental abscess ($p=0.0016$). These findings suggested that IRT can be used as another accurate diagnostic tool that makes it possible to determine thermal differences in cases of dental abscesses.

The thermographic examination should be performed by an appropriately trained and qualified professional who knows how to deal with the different variables that may interfere with the final result of the thermoscopic and thermographic evaluation. Haddad et al. (2016) (20) recommend that the examination had to be performed in the morning, after thermal adequacy of 20 minutes, with the patient seated in the dental chair. In all studies evaluated in the present systematic review, it was found that the authors followed this care protocol before performing the thermographic recording.

Skin temperature is determined as a function of blood flow controlled by the neurovegetative nervous system (13). The temperature affects both sides of the body evenly and simultaneously, which results in thermal symmetry. Asymmetric patterns are considered those equal to or greater than 0.3°C, which usually occurs when there is a sympathetic change or in the presence of traumatic injury, inflammatory or local vascular change (18). Based on this premise, IRT can also be indicated as a complementary diagnostic resource for clinical pictures of bone fractures in the buccomaxillofacial complex. Durnovo et al. (2014) (17) found a significant increase in temperature indices in traumatic injuries such as LeFort type and mandibular fractures.

Of the seven studies analyzed, the QUADAS 2 assessment was applied only in two studies (17, 18). This tool consists in four key domains: patient selection, index test, reference standard, and flow and timing. In both studies, all domains demonstrated a low risk of bias and adequate applicability concerns. It is noteworthy that the potential publication bias, where the limited number of articles led us to lower the degree of evidence.

Given the successful evidence of the use of IRT reported in the present systematic review, the authors suggest that it may be used more widely in Dentistry. However, this study has limitations. The main one is that few prospective studies about IRT use it to diagnose pulpitis, orofacial pain, dentoalveolar abscess, and facial fracture.

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Address for correspondence

Alena Medrado, Department of Oral Pathology, Dentistry Course, Bahiana School of Medicine and Public Health, Silveira Martins Avenue 3386, Cabula, Salvador, Bahia, Brazil.
E-mail:apmedrado@bahiana.edu.br

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Whole-body thermographic assessment of patients with stroke sequelae who report temperature differences between the sides

Caren da Silva Dias[1], Fábio Marcon Alfieri [1,2]; Artur Cesar Aquino dos Santos[1], Linamara Rizzo Battistella[1,3]

1 Centro de Pesquisa Clinica, Instituto de Medicina Fisica e Reabilitacao, Hospital das Clinicas HCFMUSP, Faculdade de Medicina, Universidade de Sao Paulo, Sao Paulo, SP, BR,
2 Master Course in Health Promotion - Adventist University of Sao Paulo (UNASP), Sao Paulo, Brazil.
3 Faculdade de Medicina FMUSP, Universidade de Sao Paulo, Sao Paulo, SP, BR

SUMMARY

BACKGROUND: Among the several changes caused by Cerebral Vascular Accident (CVA or stroke), alterations in skin temperature sensation, especially on the lower extremities, may be onset. Therefore, investigating skin temperature of the whole body of these patients with infra-red thermography might be meaningful. The objective of this study was to assess the whole-body temperature distribution of patients with stroke sequelae who report temperature differences between the sides of the body.

MATERIALS AND METHODS: This is an observational and cross-sectional study with 43 patients with stroke sequelae conducted in a physical rehabilitation facility. Participants had their temperature measured by FLIR T650sc infrared thermography camera, and the thermographic images were analyzed with the software FLIR Tools®. Statistical analysis was conducted with Student's T-test for paired samples, and statistical significance was considered if p<0.005, after single-step correction for multiple comparisons.

RESULTS: Significant temperature differences were found between both sides of the body in all Regions of Interest (ROIs), especially in the distal areas, as the average temperature difference was as significant as 0.7ºC.

CONCLUSIONS: Patients with stroke sequelae who report temperature differences between the sides of the body have lower temperatures on the plegic limb than the contralateral limb.

KEYWORDS: Stroke; cutaneous temperature; Thermography; Thermal sensation

THERMOGRAFISCHE GANZKÖRPERUNTERSUCHUNG VON PATIENTEN, DIE NACH SCHLAGANFALL TEMPERATURUNTERSCHIEDE ZWISCHEN DEN KÖRPERSEITEN ANGEBEN

HINTERGRUND: Unter den verschiedenen Veränderungen, die durch ein zerebrales Gefäßereignis (CVA oder Schlaganfall) verursacht werden, können Veränderungen der Hauttemperaturempfindung, insbesondere an den unteren Extremitäten, auftreten. Daher könnte es sinnvoll sein, bei diesen Patienten mittels Infrarot-Thermografie die Hauttemperatur am ganzen Körper zu untersuchen. Das Ziel dieser Studie war es, die Temperaturverteilung an der gesamten Körperoberfläche von Patienten, die nach Schlaganfall Temperaturunterschiede zwischen den Körperseiten angeben, zu beurteilen.

MATERIAL UND METHODEN: Dies ist eine Beobachtungs- und Querschnittsstudie mit 43 Patienten mit Schlaganfallfolgen, die in einer physikalisch-medizinischen Rehabilitationseinrichtung durchgeführt wurde. Die Hauttemperatur der Teilnehmer wurde mit der Infrarot-Thermografiekamera FLIR T650sc gemessen, und die Thermografiebilder wurden mit der Software FLIR Tools® analysiert. Die statistische Analyse wurde mit dem Student-T-Test für gepaarte Stichproben durchgeführt, und statistische Signifikanz wurde berücksichtigt, wenn nach einstufiger Korrektur für multiple Vergleiche p < 0,005 war.

ERGEBNISSE: Signifikante Temperaturunterschiede wurden zwischen beiden Seiten des Körpers in allen Regions of Interest (ROIs) gefunden, insbesondere in den distalen Bereichen, wo der signifikante durchschnittliche Temperaturunterschied 0,7 °C betrug.

SCHLUSSFOLGERUNGEN: Patienten mit Schlaganfallfolgen, die über Unterschiede im Wärmeempfinden zwischen den Körperseiten berichten, haben niedrigere Temperaturen an der plegischen Extremität als an der kontralateralen Extremität

SCHLÜSSELWÖRTER: Schlaganfall; Hauttemperatur; Thermografie; Wärmeempfinden

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Introduction

The temperature distribution of body hemispheres should be symmetrical [1,2]. The temperature difference between both sides of the body among healthy individuals is close to 0º, however, some studies report that physiological variations may generate up to 0.3ºC of difference [2-6]. Asymmetry equal to or greater than 0.7 ºC can be considered an abnormality indicating significant physiological or anatomical disturbances [5].

Cerebral Vascular Accident (CVA or stroke) can change the temperature sensation on the plegic side compared to the healthy side [7]. The feeling of cold in the plegic limb is commonly reported by individuals with stroke sequelae. The plegic upper limb can be colder than the contralateral limb by 1°C to 5°C [8].

Regarding thermal evaluation, one way to assess skin temperature is cutaneous infrared thermography, the most efficient method for studying the distribution of cutaneous temperature [9,10], as it reflects cutaneous blood circulation [11]. The use of this technique has been suitable for medicine because it is completely painless, non-invasive, quick, without contraindications and side effects, and a significant indicator of physiological dysfunctions [10,12]. An example is of thermography application is the mapping of ischemic tissue areas [5,9,10,13].

A recent study by our group observed that more than half of individuals with stroke sequelae reported this thermal change in the plegic side. The skin temperature assessed by thermography showed to be different concerning healthy individuals. The hands and feet of individuals with stroke sequelae were evaluated, and the temperature of the foot on the plegic side was found to be colder compared to the non-affected side [7].

The feeling of cold in the hand can be severe and distressing in some patients with hemiplegia. Even symptomatic patients have a lower temperature in the skin of the fingers at rest and after a cold stress test (standard cold stress) [14,15]. In a previous study of our group, we observed the skin temperature of individuals after stroke with and without sensation of temperature changes. We managed to demonstrate that sensorimotor recovery measured by Fugl-Meyer Assessment was better in the group of patients without the sensation of temperature alteration. However, although we evaluated whole-body temperature, the objective of this study was to demonstrate the associations among tactile sensitivity, cutaneous temperature, subjective temperature perception, and sensorimotor recovery of patients with stroke sequelae, regardless of regional temperatures of the body [16]. Moreover, as there is still no report on whole-body skin temperatures, this present study (an ancillary of the aforementioned study) was written. Therefore, the objective of this study was to verify the distribution of whole-body skin temperature in patients with stroke sequelae patients who report temperature differences between the sides of the body.

Methods

This study was conducted at the Institute of Physical Medicine and Rehabilitation (IMREA) of the Faculty of Medicine, University of São Paulo, after approval by the Ethics Committee Comitê de Ética para Análise de Projetos de Pesquisa (CAPPesq), registration number 2.335.371.

For this observational cross-sectional study, individuals were recruited, screened, and included after giving written consent for their participation and meeting the following inclusion criteria: above 18 years of age, with previous stroke diagnosis, and time since stroke diagnosis between 3 and 36 months. This study did not include severe cognitive disorders that jeopardized understanding of the assessments, with peripheral nerve damage, diabetes, peripheral arterial disease or tumors, or systemic autoimmune diseases.

Assessments

An anamnesis was conducted to retain clinical and demographic characteristics such as age, sex, weight, height, time and type of injury, and rehabilitation time.

After collecting the data, the thermography was performed.The body temperature was assessed with infrared thermography. This exam was conducted at the Thermography Laboratory of the Institute of Physical Medicine and Rehabilitation (IMREA). The procedures and the standardization for the thermography assessment were conducted according to the literature recommendations [5,10, 17-20]. The thermographic images were captured by a FLIR T650SC infrared sensor, with a resolution of 640 × 480 pixels, at a frequency of 30 Hz. This sensor can collect images with a temperature range from - 40 to 70 °C, with a precision of 1%, and a spectral band of 7.4-14 μm, NETD < 20 mK. The thermic sensibility of 0.03 °C was used with a colorimetric scale (colour palette), considering a skin emissivity of 0.98. Both anterior and posterior incidences of right and left sides of upper and lower limbs were collected (figure 1)

As described in the previous studies [16,17] each ROI was standardized rectangles within anatomical regions, as follows: 1-hand, the junction of the third metacarpal with the third proximal phalanx and the cubital styloid process; 2-forearm, distal forearm, and cubital fossa; 3-arm, cubital fossa and axillar line; 4-thigh, 5 cm above the upper bond of the patella and the inguinal line; 5-leg, 5 cm below the lower bond of the patella and 10 cm above the malleolus. This evaluation was also described in other studies [6, 16,17]. The temperature scale used was Celsius, and the data under analysis were the mean temperature of each ROI. All images were analyzed with FLIR Tools software.

The preparation of patients was oriented not to have a bath or hot showers, use ointments or powders, or join vigorous physical exercises two hours before evaluations. They should not eat within the two hours before the assessment and were asked not to ingest stimulating substances, caffeine, or alcoholic drinks, not smoke, and not use any nasal decongestant. At last, the patients were acclimatized for 20 min so that the skin reached a thermic balance with the environment. Patients were not evaluated for signs of infection, such as fever [16].

Before collecting thermographic images, the participants were asked to wear a bathing suit (bikini or swimming trunks) or underwear to uncover the lower and upper limbs and trunk. In addition, they were asked to remove any adornments such as necklaces, bracelets, and watches.

For climatization, the participants remained for 20 minutes in a room with an average temperature of 21°C and relative air humidity on average of 65%. Also, the room had the windows and curtains closed. All evaluations were conducted in the morning, and the participants were asked to stand at a distance of 4 meters from the infrared sensor and 0.4 m from the wall behind them. They were instructed not to make movements with arms or legs and not to scratch any body region before or during the infra-red image capture.

Data analysis

Results were presented as means ± standard deviations. Data normality was assessed with the Shapiro-Wilk test. Paired Student's t-test was used to compare the plegic and the contralateral sides of the body.

Given the necessity for multiple comparisons (10 comparisons), the alpha level was corrected, and statistical significance was reached if $p < 0.005$. The approach for the correction was the single-step correction for multiple comparisons [21]. The analysis was conducted with Stata14®.

Results

The mean age of the 43 subjects included in this study was 58.97±13.59 and 53.49% were male patients. The demographic and clinical characteristics of the patients with stroke sequelae are described in table 1.

Table 1
Clinical and demographical characteristics of stroke patients who reported the sensation of a colder plegic limb.

Characteristics	Distribution (n=43)
Sex (Female/Male), n (%)	20/23 (46.51% / 53.49)
Age, mean (SD)	59.0 ±13.6
BMI (Kg/cm²), mean (SD)	25.1±4.1
Stroke etiology (I/H/T), n (%)	28/11/4(65.1%;25.6%;9.3%)
Time since stroke (months), mean (SD)	21.3±7.6
Rehabilitation time (months), mean (SD)	14.5±9.1

SD, standard deviation; I, ischemic; H, haemorrhagic; T, ischaemic with haemorrhagic transformation.

Figure 1
Images of upper and left sides of upper and lower limbs.

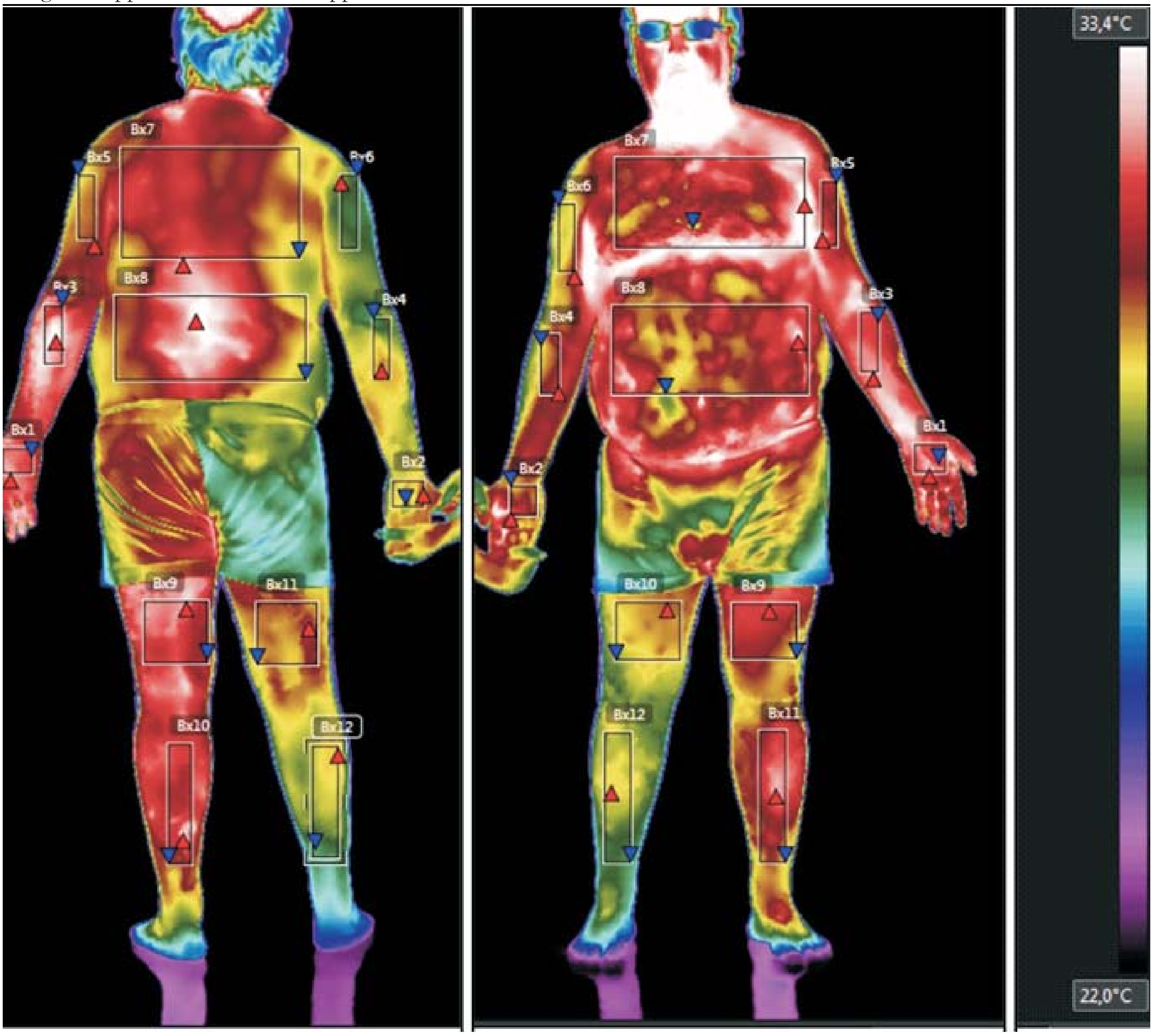

Table 2 -
Temperature distribution and statistical comparisons between the plegic and contralateral sides of patients with stroke.

ROI	Side	Temperature distribution	P-value*
Ventral hand	P	30.2 ±1.9	0.023
	C	30.6 ±2.5	
Ventral forearm	P	31.4 ±0.8	0.001
	C	31.8 ±0.8	
Ventral arm	P	30.6 ±0.9	<0.0001
	C	31.1 ±0.8	
Ventral thigh	P	30.1 ±0.8	<0.0001
	C	30.6 ±0.8	
Ventral leg	P	29.7 ±1.2	<0.0001
	C	30.7 ±0.9	
Thorax	-	31.9 ±0.6	-
Abdomen	-	31.8 ±0.9	-
Dorsal hand	P	29.2 ±1.6	<0.0001
	C	30.0 ±1.5	
Dorsal forearm	P	29.9 ±0.9	<0.0001
	C	31.2 ±0.9	
Dorsal arm	P	29.4 ±0.9	<0.0001
	C	29.9 ±0.9	
Dorsal thigh	P	30.5 ±0.9	<0.0001
	C	30.9 ±0.9	
Dorsal leg	P	28.9 ±1.1	<0.0001
	C	29.7 ±1.0	
Dorsal spine	-	31.7 ±0.7	-
Lumbar spine	-	31.6 ±0.8	-

* Statistical significance if $p < 0.005$; ROI, region of interest; P, plegic; C, contralateral.

The analysis of the temperature differences between the healthy and contralateral sides exhibits statistically significant differences in all regions of interest (ROIs) assessed. The overall mean temperature difference between the sides was as high as 0.7°C. The regions that showed the most significant differences were the dorsal forearm, ventral leg, and dorsal hand. Temperature values and analysis are shown in table 2.

Discussion

This study aimed to verify body temperature distribution in individuals with stroke sequelae, assessed by infrared thermography. This assessment has already been used in a previous study in this population [7,16].

In our study, individuals with altered thermal sensation reported that the plegic limb was colder than the contralateral limb, even though the temperature differences were lower than a previous study on the same matter [7]. This study [7] found differences as significant as 6.1ºC and 6.7ºC for upper and lower limbs, respectively. In contrast, in the present study, our data indicated a difference of 4.9ºC for upper limbs and 4.2ºC for lower limbs.

Confirming previous findings [7] that the plegic side is significantly colder, it was found that the plegic side has lower temperatures compared to the healthy side. Also, these findings agree with studies that showed stroke patients report feeling coldness in the plegic side and that the plegic side is indeed colder when compared to the contralateral side [8,15,22].

As for the general temperature of the evaluated ROIs, we observed that the highest values analysed were for the dorsal thigh and ventral forearm regions. In contrast, the lowest values were found in the dorsal leg and hand. The mean temperature difference between the plegic and contralateral side was 0.67°C that is, the average temperature difference is above the suggestion of symmetry found in the literature [23]. These values of temperature differences between both sides of the body indicate that individuals with stroke sequelae have physiological dysfunction of temperature regulation as they present a difference of over half a degree [23,24].

Regarding the temperatures of the chest, abdomen, dorsal and lumbar spine, the values are very similar to the values in healthy individuals (31.9°C, 31.5°C, 31.7°C, and 31.2°C, respectively) [6], suggesting that stroke does not seem to affect the temperatures of the more centralized parts of the body.

In this study, we observed that the temperatures of the distal regions of the upper limbs (ventral region of hands) have lower values compared to proximal regions (forearm and arm), similarly to what was found in a study that assessed healthy men. A probable explanation for this finding is that these ROIs are distant from the heat-generating organs [25]. However, we believe that this hypothesis should be better studied in future researches.

Another question raised in the present study is the possible interference of lack of mobility on the plegic side to explain the temperature differences. However, as seen in another study [7], there is no association between motricity (assessed by the NIHSS scale) and the temperature differences of the plegic and contralateral sides. Nonetheless, as mentioned in another study [16], there is an association between motor recovery and tactile sensitivity and skin temperature, indicating that a more significant sensorimotor recovery is found as the difference in temperature or tactile sensitivity is closer to zero. For this reason, we believe that associating other forms of assessment, such as the level of muscle strength, degree of spasticity, and functional mobility, can bring relevant information on this matter.

This study was based on infrared thermography and showed detectable temperature differences between both sides of the body after a stroke. Therefore, we believe that this form of assessment should be incorporated as a measurement of clinical outcomes in rehabilitation to measure and monitor the patient complaint of cold in the plegic side.

As limiting factors of the study are the lack of a control group, the lack of spasticity and muscle strength assessments, and the lack of assessment of image examination of the brain injury. However, our data was sufficient to address the study's primary objective. Future studies should consider the location and size of the injured area of the brain to provide more detailed information on the subject. Also, studies that assess and measure the effectiveness of different interventions on the temperature differences should be conducted.

Conclusion

The results of this study allow us to conclude that the skin temperature of individuals with stroke sequelae who report temperature differences between the sides of the body is disturbed as the plegic limb is significantly lower than the contralateral side in all evaluated segments, regardless of the proximity with the heat-generating organs.

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Address for Correspondence

Fábio Marcon Alfieri

Clinical Research Center,
Institute of Physical Medicine and Rehabilitation, University of Sao Paulo School of Medicine,
Rua Domingo de Soto 100, Vila Mariana,
04116-030, Sao Paulo, SP, Brazil

Email: fabiomarcon@bol.com.br

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News in Thermology

Infrared article awarded

Peter Henderson MD, MBA, a faculty member and breast reconstruction microsurgeon at Mount Sinai in New York City, developed with Paul Shay MD and Eric Bao, first year Medical Student the DIEB Database (http://diepdive.org/). This website is dedicated to Deep Inferior Epigastric Perforator Flap Breast Reconstruction that has become the gold standard for autologous breast reconstruction since it was first described in 1994. The website containsd a comprehensive database of the past 25 years of DIEP breast reconstruction, with about 2650 entries ranging from clinical cases to surgical techniques. In order to recognize those who have made significant contributions to the autologous breast reconstruction literature, Paul Henderson and his team have started a series of awards.

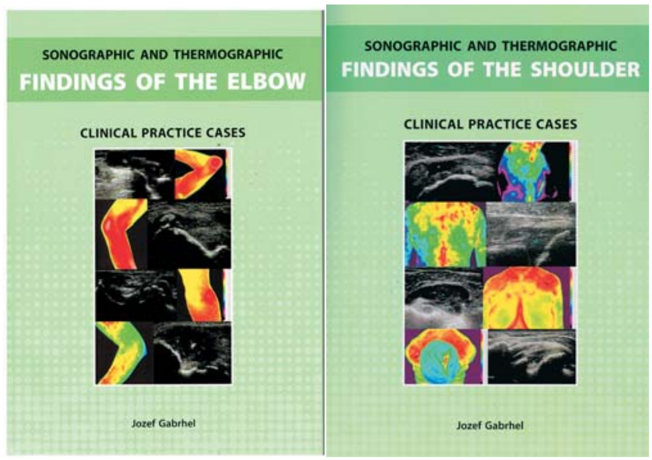
Upon reviewing the new publications that were entered into the database for the calendar year 2021 (198 papers), the article entitled: "In Vivo Perforasome Perfusion in Hemi-DIEP Flaps Evaluated with Indocyanine-green Fluorescence Angiography and Infrared Thermography by Muiz A. Chaudhry, James B. Mercer and Louis de Weerd, published in (Plast Reconstr Surg Glob Open2021;9:e3560; doi: 10.1097/GOX.0000000000003560; Published online 21 May 2021." stood out as being a particularly exceptional paper. Accordingly, the authors from Norway were congratulated on being awarded the inaugural
"2021 DIEPDive.org Award - Best paper."

The former EAT president James Mercer, main initiator and promoter in establishing infrared imaging as a method for perforator detection in flap surgery, was pleased by this award.

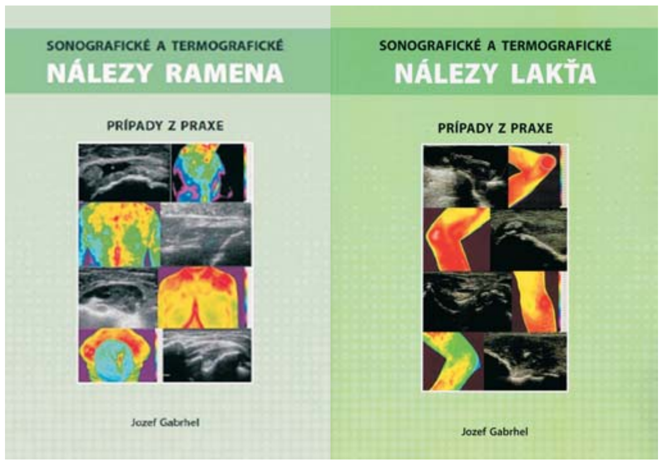
Book series on infrared and sonographic imaging extended

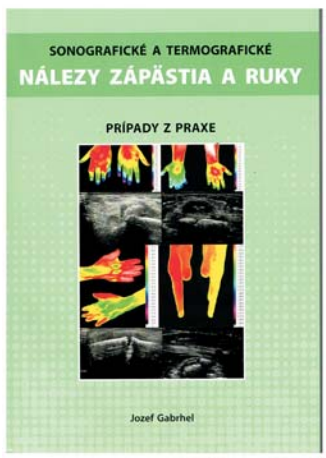
Jozef Gabrhel has added two volumes to his case book series on infrared and sonographic imaging. An English version of "Sonographic and Thermographic Findings at the Elbow" and a new volume in Slovak language on "Findings at the hand" are now available.

The latter book is dedicated to **Doc MUDr Helena Tauchmannova, CSc**., the Slovak doyenne of both thermography and Physical Medicine & Rehabilitation The book presents in total 60 cases, 13 with pathologies located in the wrist/carpus and 47 patients with findings obtained at the digits. As expected, sonography performed in bony and tendinous structures better than thermography in lesion detection. Images from patients with diffof use swelling such as CRPS or lymphedema or acute flares rheumatoid arthritis are missing and should be added to a future English version of the book.



The series has currently 5 volumes, 3 in Slovak language and 2 in English encompassing in total 320 cases being the most comprehensive collection of thermal and sonographic images captured from the human upper extremity. If Dr Gabrhel continues with this series presenting in future volumes images from the lower extremity, the neck, the upper and the lower back and from the head/face, this case collection may exceed 1000 pictorial findings.





2022

4th-8th July 2022

16th QIRT Conference in Paris, France

Venue: FIAP Jean Monnet
30 Rue Cabanis
75014 Paris, France

Further information on pages 21 to 22

8th – 10th August 2022

16th International Conference on Heat Transfer, Fluid Mechanics and Thermodynamics (HEFAT 2022) at the Anantara Grand Hotel Krasnapolsky, Amsterdam, Netherlands.

The Organizing Committee of the International Conference on Heat Transfer, Fluid Mechanics and Thermodynamics (HEFAT) and the Editorial Board of Applied Thermal Engineering (ATE) are delighted to announce that we have established a partnership, since 2021. HEFAT will form the main forum for the board, authors, reviewers, and guests of ATE from all over the world, to meet and exchange ideas in overlapping research, innovation, and development areas. The HEFAT-ATE conference will form a regular opportunity for the Editorial Board of ATE to have its board meetings and allow authors and presenters the opportunity to meet both the board and representatives of the publisher, Elsevier.

From the HEFAT-ATE 2021 conference we have selected 103 papers to be considered to be published in a special issue of the journal Applied Thermal Engineering. For this HEFAT-ATE 2022 conference good papers that fall within the scope of the journal will again be selected to be considered to be published within a special issue of ATE.

The conference is co-sponsored by the International Centre for Heat and Mass Transfer (ICHMT) and the American Society of Thermal and Fluids Engineering (ASTFE).

Global COVID-19 circumstances and related restrictions may necessitate the move to a purely virtual format at a later stage. We will communicate this in advance and accommodate registrations accordingly.

Conference Website: https://hefat2022.org

Submission & Review Portal:
https://hefat2022.org/registration

Important Dates:

Monday, 28 February 2022:
Deadline for submission of abstracts

Thursday, 31 March 2022:
Deadline for submission of full papers

COMMITTEES

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P. Bison (Italy) & Vice Chair
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T. Toullier (UGE)

Qirt Short courses

In addition to the main technical program, the conference will be complemented by one-day short courses on Monday, 4th July 2022, taking place in the conference center at FIAP.

GENERAL INFORMATION

Website

The https://qirt2022.sciencesconf.org/ website has been prepared for the conference.
All news and updates will appear on this page.

Fees (VAT included)

Regular Full - Early bird:
until 31st May 2022: 600.00 €*
from 1st June 2022: 700.00 €*
Students :
300.00 €* (Early Bird)
350.00€* (Full from 1st June 2022)
QIRT Short Courses: 160.00 €
*including all conference activities, conference dinner, lunch and refreshments

Cancelation

by 31st May 2022: 50 % of participation fee
from 15th June 2022: no refund possible

Local Organisation

Conference Secretariat
Ms. Edith Blin | Inria | France
E-mail: edith.blin@inria.fr

Local Programme Organiser
Dr. Jean Dumoulin | Université Gustave Eiffel | France
E-mail: jean.dumoulin@univ-eiffel.fr

Venue

FIAP Jean Monnet
30 Rue Cabanis
75014 Paris | France

New dates for abstract submission & acceptation

Hotel Reservation

We will arrange special conditions in different hotels. Information and booking informations will be put at the conference website.
For inexpensive accommodations, a specific arrangement for rooms will be proposed with FIAP Jean Monnet. Informations will be put at the conference website.

UPEC Université Paris-Est Créteil Val de Marne
Inria
Université Gustave Eiffel

In partnership with SFT Société Française de Thermique

THIRD ANNOUNCEMENT

CALL FOR PAPERS

QIRT'2022

16th Quantitative InfraRed Thermography conference

4th – 8th July 2022 in Paris, France

AIMS and CONTENTS

We cordially invite all experts, users, scientists, young researchers and students being active or interested in the field of quantitative thermography to attend the 16th Quantitative Infrared Thermography Conference (QIRT'2022). The conference will take place in Paris, at FIAP Jean Monet, close to historical centres and public transportation systems.

This year, the conference is organised by the University Gustave Eiffel (UGE), University Paris-Est Créteil (UPEC) and the National Institute for Research in Digital Science and Technology (Inria). The organisers are strongly supported by the Steering Committee of the QIRT community, by the International Scientific Committee and by the Local Organising Committee. The conference will be complemented by QIRT Short Courses, by an exhibition where the newest infrared thermography equipment will be presented and by a social program.

We are looking forward to your interesting and innovative contributions, which will contribute to scientific and technical presentations, posters and fruitful discussions.

On behalf of the Local Organizing Committee

Dr. Jean Dumoulin & Dr. Laurent Mevel & Pr. Laurent Ibos

16th Quantitative InfraRed Thermography conference

QIRT'2022 *4th – 8th July 2022 in Paris, France*

Exhibition

A vendor exhibition will complement the technical presentations.

The price for 1 standard booth of 6 m² (incl. 1 table, 2 chairs, standard plug, W-LAN, 1 poster wall (on request)) is **1,500 € plus Value Added Tax (VAT)**.

For each booth one conference ticket with full conference participation will be provided.

The number of booths is limited. They will be assigned on a first come, first serve basis.

Book your booth by 15 May 2022

via https://qirt2022.sciencesconf.org/ .

STRUCTURE

Scope

The biannual Quantitative InfraRed Thermography (QIRT) Conference is a meeting of the scientific and industrial community interested and actively working in research, application and technology related to infrared thermography.

All conference topics are intended to quantitative results comprising temperature values as well as further parameters on the tested materials and structures. The latter ones are usually obtained through active thermography, *e.g.* by exploiting nonstationary heat transfer processes activated by additional heat sources or by considering wavelength dependent effects.

Passive and active thermography methods and technologies are spread now along a multitude of areas of applications, which all profit from each other.

Topics

• State-of-the-art and evolution in the field of infrared scanners and imaging systems allowing quantitative measurements, and related data acquisition and processing systems

• Calibration and characterisation of infrared cameras and related topics like certification, standardisation, validation, emissivity determination, absorption in media, translucent media, spurious radiations, three dimensionality of observed objects

• Characterisation of optical and further heat sources for active thermography

• Analytical and numerical modeling, data reduction, signal and image processing, artificial intelligence related to infrared thermography

• Application of infrared thermography to radiometry, thermometry, and physical parameters identification and quantification, in all fields: fluid mechanics, solid mechanics, structures and material sciences, non-destructive evaluations, electromagnetism, medicine and biomedical sciences, remote sensing, environment monitoring, industrial processes, multiscale, multispectral and other.

Key Dates for authors

New dates

Deadline for abstract submission: **21 February 2022**

Acceptance notification: ~~February 2022~~ **7 March 2022**

Deadline for booth reservation: 15 May 2022

Deadline for full paper submission: 31 May 2022

Deadline for author on-line registration : 15th June 2022

CALL FOR PAPERS

Submission Guidelines

You are invited to submit abstracts in accordance with the following guidelines:

- ✓ Authors may register more than one paper.
- ✓ English being the conference language, the contributions must be submitted in English. Translation into other languages will not be provided.
- ✓ All contributions must be submitted online at: https://qirt2022.sciencesconf.org/ by **21 February 2022**.

Please submit a short abstract of 100 words within a two page extended abstract formatted according to the template which can be found on the conference website.

- ✓ Authors will be informed about the acceptance of their contributions by 7 March 2022.
- ✓ Authors whose paper was accepted must register and pay the registration fee before 15th June 2022.

The registration is binding.

- ✓ Registrations of papers will only be considered if they are submitted together with all relevant data and the abstract.
- ✓ The full paper (in English) must be received by QIRT'2022 organizers as an electronic file by 31 May 2022.

Publication of Best Papers

After the conference, all papers will be evaluated by the QIRT Committees and the best papers will be published in the QIRT Journal.

These papers should not already be published in any conference proceedings or journals and the work should be original and new. A peer review process by independent, anonymous expert referees will be performed.

Student Award

The best student paper will be honoured with the Student Award. During abstract submission you can choose if your abstract is suitable for the student award.

The presenting student must be enroled at a university and the presented work must be developed within their bachelor, master or doctoral thesis. Only one submission per student candidate is accepted into the competition.

Grinzato Award

The scientific paper will be honoured by the Grinzato Award. The nominees for the Grinzato Award will be announced by the steering committee according to the rating of the submitted abstracts.