

Thermographic: a tool of aid in physical therapy diagnosis - literature review.

Termografia: uma ferramenta de auxílio no diagnóstico fisioterapêutico - revisão de literatura.

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Abstract

Introduction: Maintaining body temperature by the human body occurs through the control of the autonomic nervous system in the cutaneous microcirculation, it is necessary for there to be effective in chemical reactions and consequent maintenance of homeostasis. The human body exhibits a thermal symmetry. When any asymmetry occurs relating the contralateral area, there are some evidences of a series of cases, ranging from an inflammatory process to neurovascular changes. Thermography makes the analysis of the temperature distribution on the surface of the skin, being a tool that can be used in assessment and diagnosis of such disorders, contributing to the evolution of the treatment of patients led to physiotherapy services. **Objective:** To investigate the importance of thermography as an adjunct diagnostic tool in physical therapy, showing its applicability. **Method:** This is a literature review using various electronic databases such as PubMed, Science Direct, Scopus, Web of Science and SciELO, by crossing the term thermography diagnosis and therapy. The sample consisted of 8 items. **Results:** Thermography proved a useful tool in the early diagnosis allowing the evaluation of local excessive friction prostheses muscle injury, occupational disorders, ischemic areas, and joint overloads beyond the initiation of an inflammatory process, which still showed no signs and symptoms classic, providing the physiotherapist take preventative measures and perform rapid and effective intervention. **Conclusion:** It can be concluded from the present review that thermography can be used as an excellent diagnostic tool for physical therapy because it is a non invasive method with no side effects, with good sensitivity and reliability.

Keywords: Thermography; Diagnosis and physiotherapy.

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Resumo

Introdução: A manutenção da temperatura corporal pelo corpo humano ocorre através do controle do sistema nervoso autônomo sob a microcirculação cutânea, este é necessário para que haja uma eficácia nas reações químicas e consequente manutenção da homeostasia. O corpo humano exibe uma simetria térmica. Quando ocorre qualquer assimetria em relação ao território contralateral tem-se o indicativo de uma série de quadros, que vão desde a um processo inflamatório até alterações neurovasculares. A termografia faz a análise da distribuição de temperatura na superfície da pele, sendo uma ferramenta que pode ser utilizada na avaliação e no diagnóstico de tais distúrbios, contribuindo para a evolução do tratamento dos pacientes conduzidos aos serviços de fisioterapia. **Objetivo:** Verificar a importância da termografia como instrumento auxiliar no diagnóstico fisioterapêutico, mostrando sua aplicabilidade. **Método:** Trata-se de uma revisão bibliográfica, utilizando diversas bases de dados eletrônicas como Pubmed, Science Direct, Scopus, Scielo e Web of Science, por meio do cruzamento do termo termografia com diagnóstico e fisioterapia. A amostra selecionada foi composta por 8 artigos. **Resultados:** A termografia mostrou-se uma ferramenta útil no diagnóstico precoce permitindo a avaliação de lesões musculares, distúrbios ocupacionais, áreas isquêmicas, locais de atrito excessivo em próteses e sobrecargas articulares além do início de um processo inflamatório, que ainda não apresentou sinais e sintomas clássicos, propiciando que o fisioterapeuta tome medidas preventivas e realize uma intervenção rápida e eficaz. **Conclusão:** Pode-se concluir através da presente revisão que a termografia pode ser utilizada como uma excelente ferramenta de diagnóstico para a Fisioterapia por ser um método não invasivo, sem efeitos colaterais, com boa sensibilidade e confiabilidade.

Palavras-chave: Termografia; Diagnóstico e fisioterapia.

INTRODUCTION

Maintaining body temperature by the human body is a complex phenomenon. The sympathetic fibers control the motor cutaneous microcirculation through vasoconstriction or vasodilation, causing smaller or larger irrigation skin. This phenomenon of controlling heat transfer through the skin is defined as thermoregulation and is dependent on the control of the autonomic nervous system.^(1,2) Therefore, with a rigid central control, the body temperature remains at about 37 °C, and consequently, chemical reactions are processed and homeostasis is maintained.⁽³⁾

The heat produced by the human body is transmitted via infrared rays which are invisible to the naked eye. Being an electromagnetic wave does not need to propagate a means being able to move with the vacuum speed of light. This issue indicates the degree of agitation among the molecules that can be perceived by your heating properties, but human hand is not able to perceive small changes in temperature. Have the infrared imaging equipment detect thermal changes of 0.05 °C to 0.1 °C and organized as a heat map.⁽²⁾

Computerized Infrared thermography is used as an effective tool for the diagnosis of various diseases because of its efficiency in the analysis of temperature distribution on the skin surface.⁽¹⁻⁶⁾ There is an advantage use the fact that a procedure safe, noninvasive, that does not involve ionizing radiation and provides objective parameters for evaluation.^(2,5,7)

The human body exhibits a thermal symmetry. When there is an asymmetry in relation to the contralateral region, this allows the diagnosis of neurovascular changes, inflammation, stress fractures, patellofemoral joint pain,

arthritis, periodontal disease, inflammation of the lacrimal tract, thyroid abnormalities, and even tumors: tumors of the thyroid, parathyroid, melanoma and breast tumors.⁽¹⁾ A difference of at least 0.3 °C is considered as thermal asymmetry.^(2,8)

The study of pain, especially with regard to ascertain their presence objectively, also received great contribution of thermal evaluation. It is possible to show various types of pain, as well as physiologic conditions, by measuring the electrical resistance of the skin. A study examining the relationship of pain in the cervical and upper end with skin resistance showed that the areas of pain corresponded to areas of low resistance (sympathetic hyperactivity) and the autonomic sympathetic nervous system (ASNS) has a close relationship with pain.⁽⁹⁾ Therefore, it is possible to document the skin changes caused by vascular phenomena due to neurovegetative reflexes in the same area of the body where the patient complains of pain.⁽¹⁰⁾

A few years ago, thermography has also been used to determine the musculoskeletal system injuries, becoming a major assist in the evaluation and diagnostic procedures.^(2,6,11,12) On this basis the objective of this study is to assess the importance of thermography as a physical therapy diagnostic procedure, showing its importance and applicability.

METHODS

This is a bibliographic review that critically elucidates in what situations thermography can aid in physical therapy diagnosis. The literature review was performed from December 2013 to February 2014, seeking scientific articles on the following databases: Pub Med, Science

Direct, Scopus, SciELO and Web of Science. The search was performed using as keywords "Thermography", "Diagnosis" and "Physical Therapy" in Portuguese and English, both indexed in MeSH-Descriptors Health Sciences, published from 2009 to 2014. They were initially found 700 articles

but only 8 articles were selected for the literature review. The identification of these items was performed according to the flowchart (Figure 1).

RESULTS

Table 1. Characteristics of selected studies.

Author	Title	Methods
Bandeira et al. ⁽¹²⁾	Pode a termografia auxiliar no diagnóstico de lesões musculares em atletas de futebol?	The study sample was composed of 18 athletes aged between 15 and 17 years. They were divided into control group (low-intensity exercise) and experimental group (high intensity). In both groups were acquired an individual thermal image of the quadriceps before exercise and 24 hours. Only in the experimental group was made evaluation of CK levels.
Results		Conclusion
There was a statistically significant correlation between lactate levels and CK and the temperature difference to the muscle studied in the experimental group. There was also a statistically significant difference in the temperature variation of the quadriceps region between the experimental and control groups.		The results suggested the possibility of using thermography in conjunction with CK to determine the location and intensity of post-training muscular injuries, since the CK can not determine the anatomical location of the muscle injury.
Author	Title	Methods
Wu et al. ⁽⁷⁾	The application of infrared thermography in the assessment of patients with coccygodynia before and after manual therapy combined with diathermy.	After a detailed history, clinical examination and dynamic radiography were selected 53 patients (6 men and 47 women) with coccygodynia. They underwent physical therapy treatment with manual therapy and short-wave diathermy three times a week for 8 weeks. It was performed an evaluation with numerical rating scale of pain (NRSP) and thermography before treatment and 12 weeks after.
Results		Conclusion
There was a statistically significant correlation between lactate levels and CK and the temperature difference to the muscle studied in the experimental group. There was also a statistically significant difference in the temperature variation of the quadriceps region between the experimental and control groups.		The results suggested the possibility of using thermography in conjunction with CK to determine the location and intensity of post-training muscular injuries, since the CK can not determine the anatomical location of the muscle injury.
Author	Title	Methods
Souza ⁽¹³⁾	Termografia como exame complementar no diagnóstico diferencial de LER/DORT em trabalhadores bancários de criciúma.	A sample of 10 volunteers. In order to measure grip strength, scapular and average forceps were used three dynamometers, one for each variable, and was performed three tests for each and the average of the three was the end result. To perform thermography the room temperature was controlled by air conditioning for reliability of the collected data.
Results		Conclusion
Thermography showed sensitivity and specificity to identify in relation to the upper limbs, and the most affected sites were the right shoulder (100%), right forearm (90%) and right wrist (50%). Thermography provided specific data of each individual sample, where the results of the reports were associated with the mean values of grip strength.		It was concluded that by observing thermographic images, it was possible to assess the strength of condition specific muscle groups of dynamometries concerned. Measure subjectively pain and physical effort expended in achieving the strength tests enabled a comparative association of thermography findings to the etiology of occurrence.

CK – Creatine Kinase; NRSP: numerical rating scale of pain; RPE: Rehabilitation program expanded, TMD – Temporomandibular dysfunction; ICC – Intraclass correlation coefficient.

Table 1. Continued...

Author	Title	Methods
Brioschi et al. ⁽⁶⁾	O uso da termografia infravermelha na avaliação do retorno ao trabalho em programa de reabilitação ampliado.	Cross-sectional study with 62 patients suffering from RSI / MSDs with chronic pain is difficult to treat. All were diagnosed and classified into different levels of commitment without the aid of thermal imaging as follows: Group 1 (G1) - immediate return to work. Group 2 (G2) - away for 60 days for RPE. Group 3 (G3) - away for six months for RPE. Group 4 (G4) - disability retirement. After this process was made thermographic evaluation.
Results		Conclusion
After clinical evaluation that got patients in each group, it was observed in the assessment by thermography the following average number of thermographic changes: G1 = 2 ± 0.2; G2 = 2.5 ± 0.9; G3 = 2.8 ± 1.1; G4 = 4.2 ± 2.0. Note the progressive increase in the number of thermographic changes the greater the withdrawal time work (P ^{***} ≤ 0.05). Inflammatory changes recorded by thermography corresponded with clinical changes.		The thermometry was demonstrated as a useful complementary method and purpose in supporting expert assessment of variables that interfere with the ability to work, since its validity and maximum degree disability. Because it is non-invasive, no side effects and significant diagnostic sensitivity.
Author	Title	Method
Magas ⁽¹⁴⁾	Avaliação da aplicação da termografia no diagnóstico de LER/DORT nas articulações do punho, carpo e metacarpo.	Sample with 33 subjects, divided into two groups: 23 people with pain in the study regions, experimental group (EG) and 10 control group (CG). The EG underwent clinical examination, ultrasound and thermography. The CG only physical and thermographic examinations. We evaluated the feasibility of thermography through comparisons with the results of the medical examination and ultrasound.
Results		Conclusion
The EG showed values of p = 0.045 for the average rate of change of temperature and p = 0.03 for average temperature difference. However, there was no statistical relationship between the level of pain and temperature changes. The thermography showed to be more sensitive (50%) compared to ultrasound (25%). But this had a higher specificity (100%) compared thermography (82%).		Thermography proved to be a useful and objective method, reaching high sensitivity and specificity with appropriate use in the diagnosis of occupational diseases.
Author	Title	Methods
Brioschi et al. ⁽¹⁵⁾	The utilization of infrared imaging for occupational disease study in industrial work.	Capture infrared images for evaluation of industrial workers. The average temperature of the thermograph was compared to the temperatures obtained from a thermopar. Also images were recorded after immersion of the hands in cold water in order to obtain parameters for comparison.
Results		Conclusion
During working hours, the surface temperatures were higher over the extensor muscles than on other structures and their spatial distributions differ dramatically from those observed before working hours.		This research showed that the work generates different thermal effects in human skin and that the occupational, physiological and pathological conditions can be monitored by infrared image.

CK – Creatine Kinase; NRSP: numerical rating scale of pain; RPE: Rehabilitation program expanded, TMD – Temporomandibular dysfunction; ICC – Intraclass correlation coefficient.

Table 1. Continued...

Author	Title	Methods
Luz et al. ⁽¹⁶⁾	Adaptação à prótese híbrida de extremidade superior: estudo termográfico de um caso.	The sample was composed of a male individual of 42 years with proximal amputation of his left arm using hybrid prosthesis. Thermographic images were obtained in two situations: the first so that the subject came to the evaluation room and the second so that the subject had its stabilized temperature in the room (21 °C). For the procedure he was asked to remove the shirt and the prosthesis.
Results		Conclusion
The values of reduced temperatures after stabilization on average 0.79°C, p<0.05. The higher initial temperature was seen in the anterior shoulder region with p <0.05, this being confirmed elevated when compared to the control member. The region with the lowest temperature after thermal equilibrium was stump region with p <0.05.		Rising temperatures in the shoulder characterized overload. And the low temperature suggests little movement and difficulty adapting and that can be used in monitoring the rehabilitation and fitting of amputees.
Author	Title	Methods
Costa et al. ⁽³⁾	Intra and inter-rater reliability of infrared image analysis of masticatory and upper trapezius muscles in women with and without temporomandibular disorder.	Were collected infrared images of the masticatory muscles and upper trapezius 64 volunteers, divided into experimental group (EG) - with TMD and control group (CG) without dysfunction. Image analysis occurred in two forms: measuring the temperature of the muscle extension and muscle center, and is performed by two observers. The intra and inter reliability was verified by the ICC.
Results		Conclusion
The intra and inter ICC values were considered excellent in both evaluations: Muscle extent of analysis and analysis of the center of the muscle; control group showed up with good intra and inter reliability.		The study showed that the measurement of the temperature of masticatory muscles and upper trapezius, performed by analyzing the extent and the center of the muscle, showed excellent intra and inter reliability.

CK - Creatine Kinase; NRSP: numerical rating scale of pain; RPE: Rehabilitation program expanded, TMD - Temporomandibular dysfunction; ICC - Intraclass correlation coefficient.

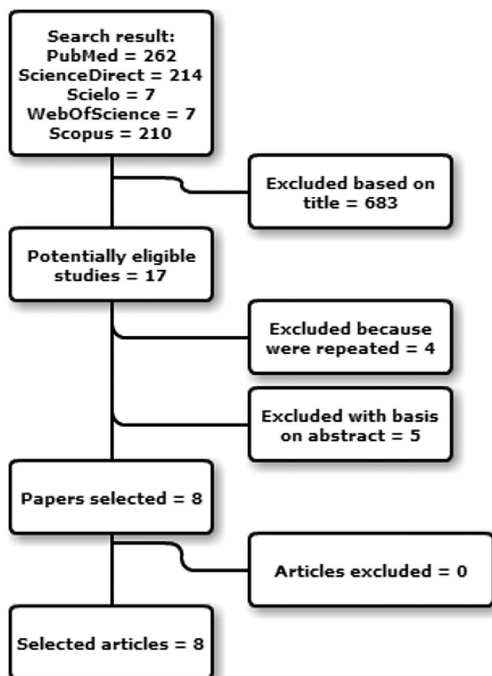


Figure 1. Flow chart indicating the steps to select articles.

DISCUSSION

In clinical practice of physical therapists is usually performed kinesiological functional diagnosis (KFD) inherent to physical therapy professionals,⁽¹⁷⁾ using semiotic and semiotechnics own concepts and appropriate terminology for defining the kinetic disorders and functional synergistic. KFD possible the establishment of conduct for the prevention, promotion, development, treatment and health recovery in individuals.^(17,18)

For these interventions become really reliable and have good results, you can make use of innovative technological resources in health. We can report as supporting resources to this process computed tomography, magnetic resonance imaging, ultrasound and thermography. These features can expand the clinical reasoning horizons, show a range of therapeutic possibilities, increase the clinical results and minimize the likelihood of therapeutic error.⁽¹⁹⁾

Thermography has proven a useful tool in terms of early diagnosis, it has high sensitivity in several situations: muscle injury, occupational disorders, ischemic areas, excessive friction addresses in prostheses, joint overloads and still in the evaluation of various activity diseases.

Through these features becomes a relevant method to perform preventive activities and early intervention.^(6,7,12-16)

Considering the detection of muscle injuries, the first study cited in the Table 1 has relevant explanations on the use of thermal imaging to detect muscle damage caused by intense training in football. Football is characterized in that it contains physically demanding and short efforts, however high power and intensity, hence after exercise have been delayed sensation of pain and discomfort, post-activity afforded by tissue damage. Assuming that a tissue injury generates an inflammatory process and that releases heat, we have the small temperature changes can be evaluated by thermography. Thus showing the beginning of an inflammatory process early, which has not yet submitted classic signs and symptoms (pain, swelling, and paresthesia) acting thus preventively.⁽¹²⁾

In the above research it can be seen that small changes in temperature between the control group (low-intensity exercise) and experimental group (high-intensity exercise) can be perceived by the thermographer. And this change coupled with high levels of creatine kinase (CK), the experimental group indicated that actually occurred muscle damage resulting from training that can be recognized by the high sensitivity of the device.⁽¹²⁾ However, the collection was not performed CK in the control group leaving open the possibility of the increase of CK levels result from another variable, that was not intense exercise.

Corroborating this research, a recent study⁽¹⁹⁾ quotes thermography as an important tool for the early diagnosis of muscular injuries. One particularly useful for detection of metabolic disorders, evaluation of inflammatory conditions and trauma evaluation⁽⁴⁾

In addition to muscle injury cited overuse, commitments is observed that often occur in sports such as medial tibial stress syndrome (MTSS)^(20,21) to which the thermal rating is able to show the traumatized areas, serving as a very useful tool in the evaluation procedures of these patients who are not diagnosed by conventional methods.⁽²²⁾

The second survey that included the results showed that thermography can be used as an objective method for assessing pain, showing that the course of physical therapy thermographic evaluation was highly correlated with the numerical rating scale of pain (NRSP) before and after treatment. It was found decreasing temperature throughout the sessions, as well as NRSP decreased.⁽⁷⁾ However other research has not found a relationship skin temperature with the pain reported by patients.⁽¹⁴⁾

Infrared assessment has contributed to the study of various types of pain, aiding the understanding of etiological factors and activity with high sensitivity. This is possible because it is produced an image of high resolution, which shows the surface of the skin microcirculation, reflecting the relationship between the sympathetic autonomic nervous system (SANS) and the cutaneous blood flow.

By thermal absorption with high precision, the infrared can sort and categorize the mechanisms involved in the performance of SANS and pain. Different patterns of pain can be identified and documented by the infrared as referred pain (visceral, somatic), pain maintained by the sympathetic, spinal pain and pain of central origin.⁽¹⁰⁾

In the same study it was concluded that the termocutaneous autonomic response in the presence of pain may help in the differential diagnosis as to its origin, objectively documenting the pain in the areas of thermatomocorporal.⁽¹⁰⁾

Another field where the Thermography has been a great ally is regarding the repetitive stress injuries (RSI) and the work-related musculoskeletal disorders (MSDs). A transversal study evaluated 62 individuals with RSI/MSDs and classified into groups according to the time away. After the thermographic evaluation, it was found that when more time off, ie, the more severe and more difficult the treatment of dysfunction, higher temperatures were found in the study area.⁽⁶⁾

Such information shows the usefulness of thermography as a tool to monitor developments, either worsening or improvement of disorders such as RSI / MSDs. These data can serve as a complement to another study, it was possible to relate the thermographic changes in individuals with RSI/MSDs to a commitment of muscle strength in the affected regions. This commitment was assessed by grip strength.⁽¹³⁾

Corroborating data quoted above, it was found that thermography is specific and appropriate sensitivity for the diagnosis of RSI/MSDs joint carpal, metacarpal and wrist, although not as specific as the ultrasound. In this study evaluated two groups, a control group and a study. The area of alleged injury and compared to the temperature change with the contralateral limb was delimited. There were significant differences in average temperature in the study group compared to the control group. But the study did not receive data with significance with regard to the relationship between the level of pain and temperature changes, requiring more studies to prove or disprove the existence of this relationship.⁽¹⁴⁾

Also in relation to occupational dysfunction, now considering two workers before and during their hours of journey, using thermography at regular intervals. Despite the small sample, we observed in both subjects increased temperature in the extensor muscles (most used at work) with the rest of the body. The temperature was higher than that observed prior to the study period. Another point to note in the survey was the thermographic evaluation after immersion in ice water, in order to obtain values for comparison. In one of the workers was observed greater difficulty in re-establishing the normal temperature in the median nerve pathway, showing a carpal tunnel syndrome. Therefore, the study shows that

thermography can be used to monitor the physiological and pathological effects of individual, even when there is no apparent symptoms.⁽¹⁵⁾

Concurrently with results regarding overload at work, a case study concerning the adjustment of the hybrid prosthesis⁽¹⁶⁾ notes were made relevant to the applicability of thermography in physical therapy diagnosis. Noting that the anterior shoulder region had the highest temperature of the images, which may characterize some sort of overload in this region, then, being a hybrid prosthesis, the whole mass, especially the myoelectric hand, is in need of greater support, overloading the proximal region to fitting the amputation stump. The identification of this overhead can thus direct the diagnostic functional kinetic guiding types of interventions such as, for example, the presence or absence of inflammation completely that would modify therapeutic behavior.

Other evidence found in the study mentioned above refers to the hypo radiated region in the residual segment to amputation. This reading can be linked to the difficulty in maintaining efficient blood flow in the extremities amputated region. The identification of these regions is fundamental for the correct fit of the prosthesis and preparation stump, since these areas with circulation deficit should be worked in order to avoid concomitant injuries.⁽¹⁶⁾

Monitoring the amputee patient should be done from the immediate postoperative period until full rehabilitation, however, errors in this process can cause ischemic compression, inflammation and/or wear on the joint member not amputated by excessive or even use the joint part above the level of amputation.⁽¹⁶⁾

Through this analysis it was found that thermography is useful in recognition of joint overload, inflammation and ischemia (featuring or not a good fit the prosthesis).⁽¹⁶⁾

To confirm the effectiveness of the discussed instrument, one study compared the thermographic evaluation results of two researchers (inter examiners) and the same researcher at different times (intra examiner). The results showed that the reliability was excellent in all aspects evaluated.⁽³⁾ Another researches agree with these results, whose objective was to evaluate the reproducibility intra and inter examiners examiners thermographic paraespinal, provided evidence that the paraspinal thermal image is a reliable diagnostic test.⁽²³⁾

CONCLUSION

It can be concluded from the present review that thermography can be used as an excellent diagnostic tool for physical therapy because it is a non-invasive, no side effects, with good sensitivity and reliability. Studies show that their results ensure greater accuracy in the diagnosis to be associated with other methods, bringing more security to evaluate various clinical changes. It is

a relatively inexpensive and diagnostic tool which can be used in the prevention and treatment monitoring when the existing disorders.

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