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Infrared thermography in adolescents with Osgood-Schlatter Disease

Termografia por imagem infravermelha em adolescentes com Lesão de Osgood-Schlatter

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Abstract

Introduction: Thermography has been used to monitor musculoskeletal disorders, but no study has assessed thermal patterns of anterior tibial tuberosity inflammation that occurs in Osgood-Schlatter Disease (OSD). **Objective:** To investigate the patterns of knee temperature in adolescents with and without OSD. **Methods:** Twenty adolescents were separated into two groups: one comprising individuals with OSD and a control in which none had OSD. An infrared image of the knees was recorded after 15 minutes of acclimatization in a temperature-controlled environment, and the maximum absolute knee temperature and the temperature difference (ΔT) between knees were obtained. **Results:** The maximum knee temperature in the OSD group was significantly higher ($p = 0.008$) than the highest recorded knee temperature in the control group. The ΔT between knees was significantly higher ($p = 0.007$) in the OSD group than in the control group. **Conclusion:** Adolescents with OSD present knee thermal asymmetry and hyper-radiant patterns in the affected knee, these alterations are prominent enough to be detected thermographically through infrared imaging.

Key words: Osteochondritis; Physical therapy specialty; Puberty; Knee; Thermography.

Resumo

Introdução: A termografia tem sido utilizada no monitoramento de desordens musculoesqueléticas, mas não há estudos avaliando os padrões de temperatura na inflamação da tuberosidade anterior da tíbia decorrente da lesão de Osgood-Schlatter (OS). Métodos: Vinte adolescentes foram divididos em grupo com OS e grupo controle sem OS. Uma imagem infravermelha dos joelhos foi registrada após 15 minutos de aclimatização em ambiente com temperatura controlada. Foi obtida a temperatura máxima absoluta dos joelhos, e calculada a diferença de temperatura (ΔT) entre estes. Resultados: O grupo com OS apresentou a temperatura máxima do joelho acometido significativamente maior ($p = 0{,}008$) do que a do joelho não acometido no controle. O ΔT entre os joelhos no grupo com OS foi significativamente maior ($p = 0{,}007$) do que no grupo controle. Conclusão: Adolescentes com OS apresentam um padrão assimétrico de temperatura na região dos joelhos, e um padrão hiper-radiante do joelho acometido, suficiente para a captação termográfica.

Descritores: Fisioterapia; Joelho; Osteocondrite; Puberdade; Termografia.

Introduction

The regular practice of physical activities provides numerous benefits for the development of children and adolescents and should be encouraged to prevent chronic diseases associated with physical inactivity[1,2].

However, the inclusion of young people in sports at puberty requires great care, especially with regard to intensity, frequency, and training duration. The level of performance, as well as expectations from parents, coaches, or individuals themselves might promote the overload of osteoarticular structures, increasing the risk of recurrent microtrauma or overuse injuries. Adolescents are more prone to these injuries due to some anatomical and physiological characteristics they possess differing from those of adults[1-3].

An important difference to be observed in the somatic development of adolescents is the imbalance in growth rate between bone and muscle: the musculotendinous structures are not able to keep up with bone growth velocity[3]. This imbalance creates tensile forces in the tendon insertion point, causing traction apophysitis, as in Osgood-Schlatter Disease (OSD)[4,5].

OSD usually occurs in girls aged 11 to 12 years and in boys between 13 and 14 years[6], as a result of patellar tendon traction over the anterior tibial tuberosity (ATT), and is characteristic of the growth spurt period[7]. It might be aggravated by repetitive forced knee extensions[7] that occur in sports-related motions, such as jumping or kicking[6,8]. Thus, adolescents who practice a sport, especially those that involve making these motions frequently (football, volleyball, or basketball), are susceptible to an increased loading of those structures, which leads to a greater propensity to develop the lesions[4].

In addition to the already-mentioned factors, there are other physiological variants that may serve as predisposing factors for OSD, such as imbalances between knee flexors and extensor muscles, changes in the patellar position, or torsions of the tibia in relation to the femur[4,6,7,9].

Infrared (IR) thermography imaging is a noninvasive method of body imaging acquisition – predominantly physiologic, without ionizing radiation – that allows measuring the temperature emitted by the body surface and mapping heat distribution associated with thermoregulatory vasomotor function[10,11].

The evaluation of the temperature through palpation with the dorsum of the hand is able to discriminate an average temperature difference of only 4 °C, while the use of thermography allows detecting differences of 0.02 °C. Since lesions are usually associated with changes in blood flow, this method confirms its relevance as a tool for promoting health[10,12,13]. However, few studies have verified whether significant temperature variations occur in knees affected by OSD and if thermography is sensitive enough to identify alterations of temperature distribution patterns in those situations.

In view of what has been exposed above, the aim of this study was to verify whether alterations of temperature patterns occur in knees of adolescents with OSD by comparing the knee temperature of affected and unaffected limbs in these individuals and also by comparing the temperature difference (ΔT) between knees of adolescents with OSD and knees of healthy control adolescents without OSD.

Material and methods

This cross-sectional study was carried out between May and June of 2011. Twenty male adolescents were divided into two groups: one comprising individuals with OSD (OSG) and a control in which none had OSD (CG).

Inclusion criteria for both groups were age between 13 and 14 years and signed consent of the parents or guardians. For OSG, additional inclusion criteria were the presence of pain in the ATT and of tumors for at least six months but less than twelve. For both groups, exclusion criteria were the occurrence of lower limb trauma up to three months prior to the evaluation and, for the CG, signs or symptoms of OSD.

The adolescents were recruited from two schools and a sport club in Porto Alegre, Rio Grande do Sul, Brazil.

The assessments were performed by the same trained examiner responsible for registering the reported information about frequency and intensity of sport activities and OSD characteristics (onset of symptoms, location and moment of the symptoms' exacerbation). The presence and intensity of pain were assessed by a Visual Analogue Scale (VAS) and scored from zero (no pain) to ten (worst pain ever felt), while tumors or edemas at the ATT were assessed by palpation.

Infrared image acquisition followed the preparation guidelines proposed by the American Academy of Thermology[14]. In the 24 hours before recording the IR image, subjects avoided the intake of caffeine or other vasoactive substances or stimulants such as tea and soft drinks; the use of moisturizers, talcum powder, or deodorant on feet and legs; and the practice of extenuating exercises.

On the day the IR images were recorded, individuals were questioned about their perception of pain intensity in the affected knee using the VAS. The IR image recording was performed by using a thermal camera suitable for IR imaging of the human body (PV320T, Eletrophysics Corp., USA) with a sensitivity of 0.08 °C and a spectral range of 7-14 μm, keeping a distance of one meter between the camera and the region of interest. The individuals remained sitting, with knees bent at 90 degrees and bare lower limbs, as shown in Figure 1, in a controlled environment with temperature at 22 °C ±1 °C. After 15 minutes of acclimatization, an IR image of the knees' anterior aspect was recorded.

The IR image analysis was performed using Velocity 2.4 (Eletrophysics Corp., USA) dedicated software. Areas of equal size were demarcated on both knees in the ATT region (Figure 2), and the maximum temperature was obtained in each area in order to determine the temperature difference (ΔT) between them.

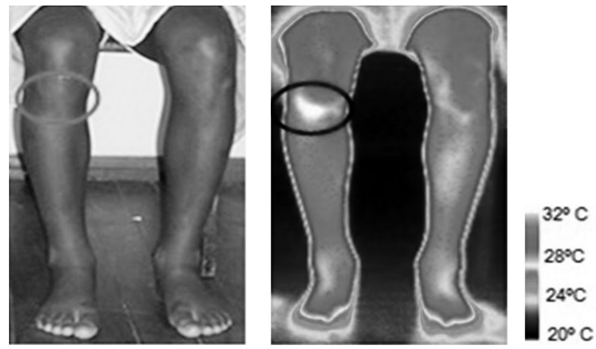

Figure 1: Individuals' positioning for acclimatization and infrared image recording

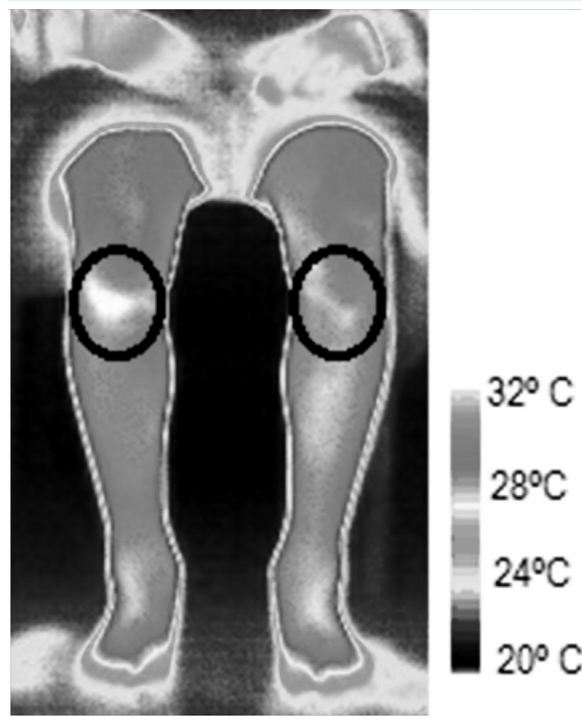

Figure 2: Equal size demarcation of both knees to obtain the maximum absolute temperature of each anterior tibial tuberosity region

The ΔT of individuals with OSG was established as the maximum temperature of the affected ATT minus the maximum temperature of the unaffected ATT. In individuals affected bilaterally, the ΔT was established as the maximum temperature of the ATT with the highest intensity of pain (determined using VAS) minus the maximum temperature of the ATT with the lowest intensity of pain. In the CG, ΔT was established as the maximun temperature of the left ATT minus the maximum temperature of the right ATT.

The study was approved by the Research Ethics Committee of Centro Metodista do IPA, Porto Alegre, Rio Grande do Sul, Brazil, under protocol n° 1/2011, and followed the resolution of the National Council of Health, CNS 196/96. The entire process of recruitment and evaluation started only after the participant and his or her parents or guardians had signed the Informed Consent.

Statistical analysis

Data are presented using the median with minimum and maximum values and absolute or relative frequencies. Comparisons of age, VAS scores and ΔT values between groups were performed using the Mann-Whitney U test. The comparison between absolute knee temperature measurements of individuals affected with OSD and those unaffected was performed using the Wilcoxon test. A significance level of 5% was adopted. Data were analyzed using SPSS software, version 17.0.

Results

Twenty male adolescents were evaluated. The CG (without OSD) comprised eleven subjects, and the OSG (with OSD) nine. In the OSG, four had OSD in the left knee (44.5%), three in the right knee (33.3%), and two in both knees (22.2%). The average time since the onset of symptoms was six months.

All the individuals practiced a sport regularly. Most individuals in the OSG played indoor soccer, and those in the CG, volleyball. The informed frequency of sports practice for both groups was five times a week.

The groups were homogeneous regarding age (p= 0.710), as shown in Table 1.

All the OSG individuals reported pain in the ATT, but 66.7% reported that pain occurred during the practice of the sport and 33.3% reported that pain occurred after the activity. On the day of IR image recording, the OSG presented a significantly higher VAS score (p<0.001) than the CG (Table 1).

Table 1: Age, pain intensity and temperature differences between knees of OSG and CG

	OSG (n=9)	CG (n=11)	P
Age (years)	13 (12-14)	13 (13-13)	0.710
VAS (0-10)	6 (1-8)	0 (0-0)	< 0,001
ΔT (°C)	0.50 (0.10-1.50)	0.10 (0.00-0.50)	0.007

OSG: Osgood-Schlatter's Disease group, CG: control group, VAS: visual analog scale of pain, ΔT: temperature difference between knees. The difference was considered significant when p < 0.05 for Mann-Whitney U test.

Regarding temperature patterns, the ΔT between knees of the OSG was higher (p= 0.007) than the ΔT between knees of the CG (Table 1). The OSG also exhibited a higher absolute maximum temperature (p= 0.008) in the affected knee compared to the unaffected knee (Figure 3), whereas no difference was found between the maximum temperatures in the knees of the CG (p= 0.437).

Discussion

The present study found that the affected ATT region of individuals with OSD showed a statistically significant higher temperature compared to the unaffected ATT and also higher temperature values compared to those found in the ATT region of individuals without OSD.

Accordingly, small traction movements of the patellar tendon cause a local inflammatory process, resulting in increased heat emissivity through the skin due to the increase in the local temperature. The physiology and anatomy of the cutaneous vascular supply create a typical healthy pattern of temperature distribution. Alterations of this pattern may have an illness as a substrate, since an injury is often related to changes in blood flow, in skin temperature and in distribution patterns[10].

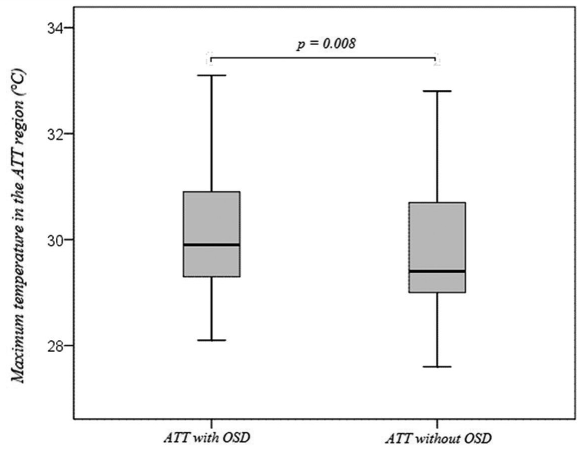

Figure 3: Maximal absolute temperatures (median and extreme values) of the ATT of knees with and without OSD in the OSG. Significant difference when $p < 0.05$ in the Wilcoxon test. ATT: anterior tibial tuberosity, OSD: Osgood-Schlatter's Disease, OSG: Osgood-Schlatter's Disease group

Thermoregulation is a process that maintains the body temperature homeostasis with as little variation as possible, regardless of the situation, in local or systemic levels. This control is accomplished through the processes of vasodilatation and vasoconstriction, leading to increased or decreased skin perfusion, respectively, and generating corresponding increased or decreased heat radiation through the skin[10]. An inflammatory process, for example, manifests itself as a hyper-radiation pattern, whereas in degenerative processes and conditions of decreased tissue perfusion this pattern is inverted[11-16]. Such description supports the thermal hyper-radiation pattern found in the ATT region of the knee affected with OSD in this study.

Regarding healthy temperature distribution patterns, Uematsu et al.[17] compared different body areas between right and left sides in 90 healthy individuals and verified the existence of a symmetrical pattern of temperature between sides, with minor differences, which were defined as the cutoff between thermal symmetry and asymmetry. In the anterior aspect of the knee, the cutoff value for symmetry, suggested by the authors, establishes a $\Delta T < 0.23$ °C ±0.17[17]. Values above this are considered as an asymmetrical thermal pattern, suggesting a dysfunction in local thermoregulation, as in the case of a lesion[11-16].

On the basis of this information, it is possible to consider that the OSG of this study presented an asymmetrical pattern between the ATT region of the knee with OSD and the knee without OSD, because the median ΔT in this region was above the cutoff point for symmetry between knee regions[17]. In addition, the knees with OSD showed higher temperatures than the knees without OSD in all individuals of the OSG. Conversely, the median ΔT between knees of the CG was below the cutoff value, signifying a pattern of thermal symmetry between corresponding knee regions.

The contributions of IR imaging through thermography for health sciences have been addressed in the literature. Among its uses are the evaluation of possible nervous system dysfunctions and autonomic and spinal disorders and the identification of lesions of peripheral nerves and soft tissues such as muscle and ligament strains, inflammation, and muscle spasms[18].

However, the authors did not find in the current literature any previous studies investigating the analysis of IR images in individuals with OSD. Nevertheless, this method is mentioned as a possibility for evaluating the development of OSD[19].

Moreover, the temperature variation assessed by thermography also may provide a prognostic indicator, as in a study by Eliyahu[19], in which subjects with hyper-radiation IR images after an ankle sprain presented a better prognosis than an individual with a hypothermic pattern, in which the trend was a slower recovery and risk of sprain recurrence.

An epidemiological study about overuse injuries in pediatric patients found that the knee was the most affected area, and OSD accounted for 61.3% of injuries, 35% of them with bilateral presentation[20]. Despite the small sample size, the present study identified 22.2% of the OSG individuals as having bilateral OSD. Furthermore, an asymmetrical thermal pattern was identified in this group, suggesting that future studies investigating the categorization of OSD presentations are necessary for a more accurate extrapolation of these results.

The present study provides new information about the viability of thermography in OSD, particularly given that the investigation of the application of this imaging modality is growing in the field of sports medicine, providing relevant information for a functional management of athletics injuries, especially those resulting from overuse, establishing its use for diagnosis, prognosis, and monitoring of treatment progress[11].

Conclusion

This study demonstrated that the inflammatory process triggered during OSD caused an increase in the local temperature by presenting a pattern of hyper-radiation sufficient for thermographic detection through infrared images of the injured areas of assessed adolescents. In addition, in this study, individuals with OSD showed a thermal asymmetry in the region of the ATT, in which the affected knee was significantly hotter than the unaffected knee, resulting in a ΔT between knees above the cutoff point for symmetry when compared to the control group without OSD, which presented ΔT values between knees below the cutoff point.

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