Application of Infrared Thermography in the Assessment of Muscle Damage in Elite Soccer Athletes

Abstract

The participation in a soccer match may result in a large number of micro-injuries leading to a number of physiological responses which, in turn, increase skin temperature (T_{sk}) of the lower limbs. The measurement of T_{sk} using infrared thermography (IRT) is being used as a tool to evaluate the internal load of the athlete in order to assist the management of training load and to help in the prevention of muscle injuries.

Keywords: Infrared thermography; Muscle damage; Skin temperature; Soccer athletes

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Abbreviations: T_{sk}: Skin Temperature; IRT: Infrared Thermography

Introduction

Participation in a soccer match results in a large number of micro-injuries originated by the eccentric mechanical actions, generating muscle fiber ruptures, cell membrane damage, and sarcomere degeneration [1]. Following this process, an acute local inflammatory response is triggered involving the release of different cytokines, migration of neutrophils to the trauma areas, and the release of certain agents into the damaged fibers to attract macrophages that ingest and digest the dead tissue, promoting temperature increase [2]. In this sense, studies have demonstrated a significant increase in t_{sk} assessed through IRT after physical effort, which could be an indicator of muscular wear, evidencing the athlete's physical exhaustion [2,3].

Discussion

The acute inflammatory response presented after soccer matches results in the appearance of some cardinal signals produced by the organism such as: heat, redness, pain and swelling [4]. The redirection of arterial blood flow to the exercised muscle generates a higher muscle temperature and a greater local cutaneous vasodilation. This process is followed by a sensation of perceived heat, as well as the redness due to the greater number of erythrocytes that transited in the affected area [4]. In addition, during the inflammatory process, the blood flow velocity is reduced, which allows the interaction of circulating cells with endothelial cells expressing surface molecules capable of binding to leukocytes [5]. It is also important to note that during exercise and post-exercise there is a release of proinflammatory cytokines TNF-α, IL-1β and IL-6 that can remain elevated for a period of 24-48 hours [6], and concomitantly act as endogenous pyrogens, thus contributing to the increase of the internal temperature [5].

Considering the factors that trigger the inflammatory process, which consequently alter the skin temperature, it has been proposed the assessment of skin temperature through IRT as an indirect way of measuring muscle damage caused by different types of exercise, especially those with eccentric characteristics. Therefore, the use of IRT can be used as a noninvasive way of measuring body's responses (heat) to the inflammatory process, and can provide valuable information about how the external load was assimilated by the athlete. Therefore, it would be important to study the potential of this strategy for controlling the training load of high performance athletes [7].

It is important to emphasize that muscular and cutaneous vasodilatation lead to increased blood flow in the exercised limb. However this is not the only reason for the increase in T_{sk}. In fact, the highest blood supply during exercise, with arterial blood at a higher temperature in muscle and skin, is the main factor that promotes the increase of T_{sk}. For example, in resting conditions, the expected blood temperature range is 36.8-37.9 °C [8] and consequently the displacement of this blood flow at a higher temperature in exercised subjects will result in a higher muscle and skin temperatures [9].

Fernandes et al. [2] studied the T_{sk} changes after a professional football match of the Brazilian championship of the First National Division. The T_{sk} 24 hours after the game ranged from 2.0 °C to 2.5°C higher in the posterior area of the thighs than before the game. However, no evidence of injury was identified by the medical staff. Therefore, the authors concluded that the increase of T_{sk} after the

match could be attributed to the inflammatory process, since the results of creatine kinase tests were also elevated 24 h after the game. Figures 1 & 2 present the thermal images recorded at the different moments in anterior and posterior views respectively.

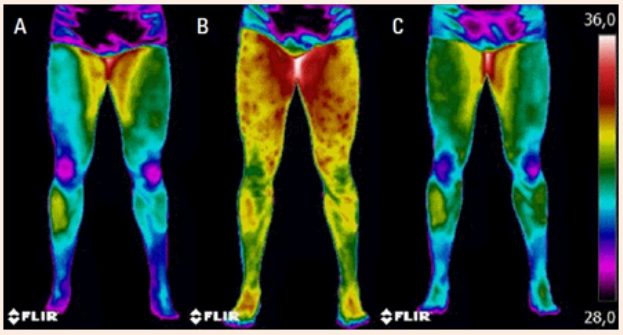

Figure 1: Thermograms of the anterior views: (A) 24 hr before the match, (B) 24 hr after starting the match, and (C) 48 hr after starting the match [2].

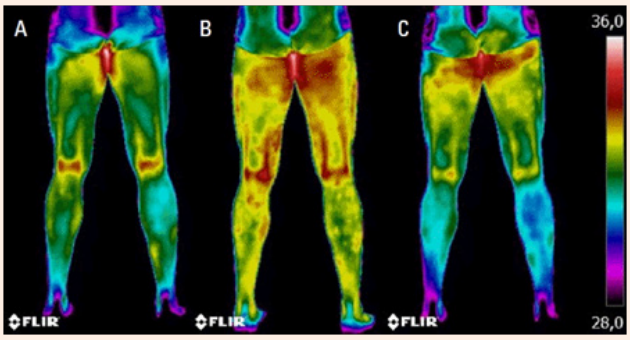

Figure 2: Thermograms of the posterior views: (A) 24 hr before the match, (B) 24 hr after starting the match, and (C) 48 hr after starting the match [2].

One of the advantages of using IRT to measure T_{sk} is the relative low cost of some infra-red camera models. Since it is a non-invasive technique, T_{sk} monitoring can be performed focusing on a particular body region of interest (local analysis) as well as a broad view of the whole body, enabling a global analysis [10,11].

Conclusion

The use of IRT may be a noninvasive alternative to measure T_{sk}, which can be applied as an indirect measure of the inflammatory process due to muscle damage, and being used as a tool to evaluate the internal load of the athlete in order to assist the management of training load and to help in the prevention of muscle injuries.

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Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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