

Chapter 44

Infrared Thermography in Swimming: Thermal Characterization of Swimming Technique

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ABSTRACT

In order to verify whether there is a considerable increase in body skin temperature during different swimming techniques (crawl and backstroke) and identifying the most affected regions. The athlete's thermal symmetry was also analyzed, as well as its modification after the swimming, according to the performed technique. The accuracy of thermography as a method to identify and distinguish these different styles was also evaluated. Ten male swimmers were recruited and two different swimming techniques were assessed, crawl and backstroke. After a 10 minute acclimatization period in the pool, the swimmers were quickly dried with microfiber towels. The thermograms were taken before and after the swimming task, which consisted in a 7x200m protocol in crawl or backstroke. Infrared thermography revealed an increase of temperature after exercise and no significant differences were found between both techniques. Thermal symmetry was not affected by exercise.

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INTRODUCTION

The study of temperature is a very comprehensive topic that applies to most contexts in science, including the study of the human body and its function. Hippocrates had already understood the importance of looking at body heat. Galileo's thermoscope was the basis for Santorio's thermometer but it was Carl Wunderlich that introduced thermal measurements into clinical medicine later in 1868. He wrote a treatise on body temperature and health as a result of his innumerable observations that allowed him to chart the temperature variations of his patients daily (Ring, 2007).

Infrared radiation had a different development, with several milestones being achieved by several pioneers in the field contributing to the development of actual infrared thermography (IRT). In 1953, Jean Batista Della Porta made very important discoveries on the reflection of heat and, more than 200 years later, the work of William Herschell and his son – John Herschell – culminated with the first known “thermogram”. JD Hardy demonstrated that the human skin behaved as a near perfect blackbody radiator and Samuel Langley contributed to the remote study of temperature with the development of the bolometer. At least, the work of Marianus Czerny on the thermal sensors and the development of an evaporograph, and the work of his former student – Bowling Barnes – resulted on the first thermal imager based on thermistors in the 1950's (Ring, 2014).

IRT is an imaging modality that has been used in medicine since the early 1960's (Ring & Ammer, 2000). Thermography is a non-invasive, non-ionizing and non-radiation emitting imaging modality that records skin temperature, providing important physiological information heat exchange processes between skin, deep tissues, local blood vessels and metabolism (Merla & Romani, 2005). The validity and reliability of technique has been widely documented in the literature (e.g. Burnham, McKinley, & Vincent, 2006).

Exercise training is known for affecting human thermoregulation, inducing changes in microvascular reactivity of the skin (Simmons, Wong, Holowatz, & Kenney, 2011). Therefore, IRT can be a powerful tool in sport medicine and research.

Early records of IRT use in sport research are available (Clark, Mullan, & Pugh, 1977; Hunold, Mietzsch, & Werner, 1992) and more recently Merla, Mattei, Di Donato, and Romani (2010) assessed skin temperature (T_{sk}) changes and distribution during graded treadmill exercise in trained subjects. Chudecka and Lubkowska (2012) reported a correlation between oxygen uptake and changes in the thermal profile of professional volleyball players after exercise. Evidence has also been reported suggesting that the magnitude of T_{sk} changes in response to localized exercise in female athletes are related to the level of physical training (Formenti et al., 2013). Bourlai, Pryor, Suyama, Reis, and Hostler (2012) reported significant correlations between skin temperature measurements of the face with IRT and measures of core temperature with ingestible core temperature capsules before, during and after treadmill exercise. Since the assessment of core temperature is vital in sport research the mass screening ability of this technique, compared to more expensive and impractical methods, can prove very useful in the future.

Swimming, as any other sport, challenges the thermal balance of the human body, increasing T_{sk} (Zaidi, Fohanno, Polidori, & Taiar, 2007) through a complex thermoregulation process that intends to preserve core temperature around 37.5°C (Bertucci, Arfaoui, Janson, & Polidori, 2013). Despite the study of Wade and Veghte (1977) and the increasing number of papers in sport research reporting the use of IRT, its use in swimming research is limited and few researchers have informed the use of this technology in swimming activities (Seixas, Gonjo, Vardasca, Gabriel, & Fernandes, 2014; Zaidi et al., 2007).

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