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Thermo-graphic Profile of Volleyball Player and its Possible Use for Injury Prevention

Berzosa C[1,2]*, Mejías-Martínez M[1,2], Valero-Campo C[1,2] and Bataller-Cervero AV[1,2]

[1]San Jorge University, Villanueva de Gállego Zaragoza, Spain
[2]ValorA Research Group, Faculty of Health Sciences, San Jorge University, Spain

Abstract

The aim of this study was to detect asymmetries on shoulder joint through infrared thermography in order to establish a thermo-graphic profile in volleyball players. 29 female volleyball players, aged 14-19 years, were enrolled in this study. Thermo-graphic assessment was performed before and after a training session, and a thermo-graphic profile was established for pectoral areas (anterior view) and scapular waist and lumbar area (posterior view) with mean temperatures obtained. Statistically significant differences were found in each area before and after the exercise session. Attending laterality, there were not significant differences between dominant and non-dominant arm.

Keywords: Shoulder; Overuse; Infrared radiation; Rotator cuff

Introduction

Infrared thermography (IRT) is a non-invasive, contactless and non-radiant tool to analyze physiological functions related to skin temperature control [1,2]. This tool is useful to detect and locate abnormalities like inflammation or infection, characterized by increase or decrease in skin temperature.

In the diagnostic pathology field, applied to sports therapy, the application of IRT has been widely used to detect different musculoskeletal injuries. It is well known that overuse injuries causes inflammation and located rise in surface temperature around the affected area. Therefore, IRT is a diagnostic tool that provides information about trauma and local inflammation, and so, about the normal function of the body part affected. In this sense, previous research settled that thermal images of both human sides are usually symmetric [1]. Any difference higher than 0.6°C could be defined as abnormal, and may suggest a variation of the normal status of the affected area [1-3].

High-performance training throws the body to the anatomical and physiological limits, and athletes could result injured. These long term injuries imply an expensive and long recovery period, which could finish athletes' careers. Focused in volleyball, the most common injuries are in rotator cuff. Rotator cuff is essential for shoulder stabilization, especially during volleyball hits and other sports gestures that imply similar demand of the joint [4]. It is an injury that increases in volleyball players, and also in other sports that require throwing, because of the overuse of these structures [5]. There are two common injury mechanisms: tendinosis with or without sub acromial bursitis, and compression and sprain. Thus, one of the more beneficial contributions of IRT to sports performance would be in the prevention field. Comparing both shoulder areas, it could be detected subclinical problems before the injury appear, causing incapacity for play. Early detection of abnormal responses of tissues to training is essential to counteract overuse injuries. Hence, identify risk factors and injury prevention will have capital importance [6].

An abnormal thermal patron is easily recognized by IRT, so it could be used to evaluate sports activity and detect possible traumas dysfunctions or muscle misbalances, that other conventional tool cannot detect at an early phase, because has not yet presented classic signs or symptoms (pain, edema and paresthesia). IRT could detect these muscle inflammation points derived from intense training [7].

The aim of this work is to demonstrate that IRT is useful to detect thermal asymmetries in volleyball players, and based on them, adequate training structure and load. We took thermal images of scapular waist of volleyball female players and analyzed temperature of upper limb muscles to establish a thermal patron of them.

Materials and Methods

As inclusion criteria, players must be female, with no medical affections and belong to an official volleyball team during 2015-16 and 2016-17 seasons. Players who suffered injuries in the study area in the last 6 months, or fall injured during the study were excluded.

IRT images were taken before (pre) and after (post) a single session of training, during competitive period (March 2017). All players wore a top which left free scapular waist, lumbar zone and pectoral muscles (both sides), with hair up. Room temperature was 25º C (± 1°C). They stay dressed as described for 10 minutes to allow surface adapt to room temperature before take IRT images. Players were in anatomical position, fontal plane, and contralateral zones were captured in the same image [1].

The study conformed to the recommendations of the Declaration of Helsinki. Participants were informed about the nature of the study and were also informed that they could withdraw from the experiment at any time. Written informed consents were obtained from the participants before the investigation.

For image analysis, Flir Tools plugin for MS Word 2013 were used.

***Corresponding author:** Dr. César Berzosa Sánchez, Faculty of Health Sciences, San Jorge University, Villanueva de Gállego. Zaragoza, Spain, Tel: (+34) 976 060 100; E-mail: cberzosa@usj.es

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Anterior zones (pectoral zones) and posterior zones (right and left scapular waist and lumbar zone) were delimited and mean temperature of each zone were calculated.

Data are presented as mean ± standard deviation (SD). Shapiro-Wilk test was applied for calculate normality and Wilcoxon test was used to detect differences. Significance was set at $p<0.05$. IBM SPSS Statistics 21.0 program were used for the statistical analysis.

Results

29 female volleyball players were involved in this study (17 ± 1 years old, 168 ± 2 cm height, and 60.2 ± 2.3 kg weight). In our study, players of every role were involved, so we establish two groups: hitters (outside hitter, opposite, blockers) and non-hitters (libero and setter). 64.3% of them were hitters. All of them were right handed except for 2 left handed.

A thermo-graphic profile was established in the upper limb of the players, according to mean temperatures obtained from anterior and posterior view. Pre and post training temperature was significantly higher ($p<0.05$) in the anterior view, followed by scapular waist and lumbar zone (Table 1).

Table 2 shows mean difference in temperatures between both sides, according to laterality. There were differences but not significant between dominant and non-dominant limb before and after training session.

Discussion

The first finding of this study was the significant differences in temperatures between different corporal zones pre and post exercise. As described previously, physical activity produces muscle heat, what increases skin temperature. Nevertheless, our data show a lower temperature after exercise (-2.6 ± 1.6°C right scapular waist, -2.5 ± 1.6°C left scapular waist, -2.9 ± 1.8°C lumbar zone, -2.1 ± 1.4°C right pectoral and -2.1 ± 1.4°C left pectoral).

There is a lack of evidence about what happens in volleyball and IRT images, and to the best of our knowledge, this is the first study in this field. The decrease in temperature could be explained because of the protocol (ten minutes of rest at room temperature) or because of the acyclic nature of this sport. In this regard, blood flow is much lower than cyclic efforts [8], thus local temperature is smaller too.

n=29	Mean ± SD		Mean ± SD	Mean dif ± SD	*p* value
Pre_RP	33.3 ± 1.2	Post_RP	31.2 ± 1.68	-2.1 ± 1.4	0.0032
Pre_LP	33.2 ± 1.1	Post_LP	31.2 ± 1.69	-2.0 ± 1.2	0.0005
Pre_RSW	32.9 ± 1.2	Post_RSW	30.2 ± 2.11	-2.6 ± 1.6	0.0023
Pre_LSW	32.8 ± 1.3	Post_LSW	30.3 ± 2.14	-2.5 ± 1.6	0.0004
Pre_LUM	32.6 ± 1.1	Post_LUM	29.7 ± 2.06	-2.9 ± 1.8	0.0160

Table 1: Upper limb thermographic profile (ºC) of female volleyball players before (Pre) and after (Post) exercise. Anterior view of right pectoral (RP) and left pectoral (LP), posterior view of right (RSW) and left scapular waist (LSW) and lumbar zone (LUM).

n=29	Mean dif ± SD	p-Value
Pre_RSW – Pre_LSW	-0.1 ± 0.2	0.42
Post_RSW– Post_LSW	-0.0 ± 0.1	0.68
Pre_RP – Pre_LP	0.1 ± 0.1	0.17
Post_RP – Post_LP	0.0 ± 0.1	0.84

Table 2: Mean temperature differences (°C) between right and left areas before (Pre) and after (Post) exercise. Anterior view of right pectoral (RP) and left pectoral (LP), posterior view of right (RSW) and left scapular waist (LSW) and lumbar zone (LUM).

Comparing right and left sides, previous researches demonstrate that both side temperatures are normally symmetric [9]. Asymmetric temperature, above 0.6°C could be defined as abnormal and could indicate any physiological or anatomical variations in locomotor system [1,3,10].

The hypothesis of the present study was that IRT is useful to detect thermal asymmetries in female volleyball players and, based on them, adequate load during the training session. Although we did not find these significant differences between dominant and non-dominant limb, there were found differences established in the warning level, according the reviewed literacy [11].

The temperature differences found are between 0.4 and 0.6°C, and were present in almost 63% of the athletes pre and post exercise, and in 50% only post exercise. It could be explained because only hitters presented differences, and these players had more load on the dominant arm than non-hitters. Chudecka et al. [12] found similar results in female handball players, so it could be interesting to program a compensatory work for non-dominant arm, to maintain or decrease these differences and balance load between extremities. The main conclusion of this study was that 50% of female volleyball players had 0.4 to 0.6°C of difference between contralateral zones, and compensatory exercises were recommended. The most affected zones were pectoral zones, followed by scapular waist and lumbar zones.

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