MEDICAL JOURNAL ARMED FORCES INDIA XXX (2017) XXX–XXX

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/mjafi

Original Article

Effect of wrist cooling on aerobic and anaerobic performance in elite sportsmen

Lt Col Anup Krishnan [a,*], Lt Col Krishan Singh [b], Col Deep Sharma [c], Lt Col Vivekanand Upadhyay [d], Maj Amit Singh [e]

[a] Medical Officer (Sports Medicine), Army Sports Institute, Pune 411040, India
[b] Graded Specialist (Physiology), Command Hospital (Southern Command), Pune 411040, India
[c] Head of Dept, Sports Medicine, Armed Forces Medical College, Pune 411040, India
[d] Medical Officer (Sports Medicine), Armed Forces Medical College, Pune 411040, India
[e] Resident, Dept of Sports Medicine, Armed Forces Medical College, Pune 411040, India

ARTICLE INFO

Article history:
Received 11 August 2016
Accepted 25 April 2017
Available online xxx

Keywords:
Wrist cooling
Aerobic performance
Anaerobic performance
Elite sportsmen

ABSTRACT

Background: Body cooling has been used to increase sporting performance and enhance recovery. Several studies have reported improvement in exercise capacities using forearm and hand cooling or only hand cooling. Wrist cooling has emerged as a portable light weight solution for precooling prior to sporting activity. The Astrand test for aerobic performance and the Wingate test for anaerobic performance are reliable and accurate tests for performance assessment. This study conducted on elite Indian athletes analyses the effects of wrist precooling on aerobic and anaerobic performance as tested by the Astrand test and the Wingate test before and after wrist precooling.

Methods: 67 elite sportsmen were administered Wingate and Astrand test under standardised conditions with and without wrist precooling using a wrist cooling device (dhamaSPORT). Paired *t*-test was applied to study effect on aerobic [VO_2 (ml/min/kg)] and anaerobic performance [peak power (W/kg) and average power (W/kg)] and Cohen's *d* was used to calculate effect size of wrist precooling.

Results: After wrist precooling, significant increase of 0.22 ($p = 0.014$, 95% CI: 0.047, 0.398) in peak power (W/kg) and 0.22 ($p < 0.0001$, 95% CI: 0.142, 0.291) was observed in average power (W/kg). Although, an increase of 1.38 ($p = 0.097$, 95% CI: −0.225, 3.012) was observed in VO_2 (ml/min/kg), wrist precooling was not significantly effective in aerobic performance. Wrist cooling effect size was smaller in VO_2 (Cohen's $d = 0.21$), peak power (Cohen's $d = 0.31$) and it was larger in average power (Cohen's $d = 0.71$).

Conclusion: Results show wrist precooling significantly improves anaerobic than aerobic performance of elite sportsmen.

* *Corresponding author*:.
E-mail address: faujidoc@rediffmail.com (A. Krishnan).
http://dx.doi.org/10.1016/j.mjafi.2017.04.004

Introduction

Human beings are homoeothermic with core temperatures between 36.1 and 37.8 °C.[1] 21–28 °C represents the comfort zone for a large majority of individuals[2] where the core temperature is easily maintained. The body maintains core temperature by initiating various heat loss or heat gain responses (thermoregulation).

Humans can tolerate a decline in core body temperature of 10 °C but a body temperature increase of only 5 °C.[1] At Core temperature above 40.5 °C metabolic enzyme functions start to deteriorate.[4] Heat stress illnesses such as heat cramp, heat syncope, heat exhaustion, heat stroke and dehydration are a major cause of morbidity and mortality during activity in heat[1,3] especially in sportsmen and active duty military personnel.

During sporting activity in heat, there occurs a definite decline in performance with increase in core temperature beyond a critical level (40–40.5 °C).[1,4–6] Cardiovascular strain (increased heart rate and decreased stroke volume) caused by redistribution of blood to the skin rather than to the exercising muscles, early utilization of glycogen stores and dehydration are the main reasons postulated for decline in performance.[1,5,6] "Central governor model for the limits of performance" which states that in response to various inputs (one of those being high core temperature), the brain regulates the number of motor units that can be recruited in the exercising limbs on a moment to moment basis, reducing the number that can be recruited when their continued recruitment, necessary to maintain the exercise intensity, threatens whole body homeostasis. The reduced recruitment of motor units thus decreases the intensity of exercise causing decline in performance.[8]

Various cooling modalities have been employed before, during and after the exercise to enhance performance and recovery.[1,3–7,9–11] Cold water immersion, ice slurry ingestion, cooling garments, cold towels, cold air blow, cold water shower, ice pack, rapid thermal exchanger device (RTX) are used either singly or in combination. The basis for precooling and during exercise cooling, is the creation of a larger thermal sink i.e. the sportsman starts exercise with a lower core temperature enabling him to exercise for a longer duration and at higher intensity before reaching the critical temperature.[5,9,10]

Over the last decade, there have been various studies employing forearm and hand or only hand cooling as a modality for precooling, cooling during exercise and after exercise.[12–18] The basis for using forearm and the hand is the presence of a large number of superficial vessels and dense arteriovenous anastomosis in this region.[2,15] Even during resting conditions under extreme thermal stress there occurs increase in blood flow to the skin from 5% of cardiac output under thermoneutral condition to approximately 15–25% of cardiac output and simultaneously there occurs six fold increases in blood flow in respect of forearm.[1,9] Therefore forearm and hand form an important source of heat loss.

Many of these studies have shown improvement in exercise capacity (endurance, strength and recovery time).[6,9,12–18] Some studies have employed direct immersion of hand and forearm[12] or only hand in cold water[13,14] others have used the rapid thermal exchange device (RTX)[6,9,15–18] which consists of a hand rest surface cooled by running water at approximately 16 °C and a vacuum source with pressure sensor to create slight sub atmospheric pressure (40 mm Hg).[9] However this device is cumbersome, costly and lacks portability.

There has been a felt need for a portable light weight technology for wrist cooling once the positive effects of cooling of the wrist with ice cubes packed in a wrist band during exercise in heat were noted. Over the last few years this technology has been under intensive research and clinical trials.[19]

There is a lack of large scale clinical trials regarding efficacy of wrist precooling and during exercise cooling on aerobic and anaerobic performance parameters in sportsmen. Hence we conducted a study to evaluate the effectiveness of a wrist cooling device on aerobic and anaerobic performance in elite sportsmen. Anaerobic performance was tested by the Wingate test[20] and aerobic performance was tested by the Astrand test[21] and, both of which are widely used for the purpose.

Materials and methods

Based on the knowledge about pre cooling effect and lack of information in Indian settings, effect size was considered as 0.35 for calculation of sample size. Level of significance at 0.05 (two-tailed), an effect size of 0.35 with 80% power, using *t*-test for same groups gave a sample size of 67 athletes to be enrolled in the study. Therefore 67 elite athletes were randomly selected for the study after Institute ethics committee approval. The inclusion criteria of the study were male athletes, 6 months of regular training and services/national level participation. The exclusion criteria were a history of hospitalization for more than 2 weeks in last 3 months due to any reason, any acute illness/injury during the study and break in training in preceding 3 weeks.

The potential risk and benefits were explained to the participants. All the participants were then given opportunity to ask questions about the tests. Written consent was taken from the randomly selected participants who fulfilled the inclusion and exclusion criteria.

dhamaSPORT wrist cooling device

Photo 1

This is a wrist cooling device designed and produced in India. It has a ceramic cooling area with dimensions of

Photo 1 – The dhamaSPORT wrist cooling device.

Please cite this article in press as: Krishnan A, et al. Effect of wrist cooling on aerobic and anaerobic performance in elite sportsmen, *Med J Armed Forces India*. (2017), http://dx.doi.org/10.1016/j.mjafi.2017.04.004