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# "สหวิทยาการงานวิจัยเพื่อพัฒนามนุษย์สู่ประเทศไทย 4.0"

BTU-SIRHDT

## เล่ม6

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## มหาวิทยาลัยกรุงเทพธนบุรี

# ผลของการลดความร้อนที่ฝ่ามือต่อการตอบสนองระบบไหลเวียนเลือดและสมรรถนะในนักกีฬาเทนนิส

# Effects of Palms Cooling on Cardiovascular Responses and Performances in Tennis Players

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บทคัดย่อ

การวิจัยนี้มีวัตถุประสงค์เพื่อศึกษาผลของการใช้เครื่องลดอุณหภูมิชนิดเร็วแบบสองมือจับระหว่างเวลา 90 วินาที ในการพักเกมส์ ของการแข่งขันเทนนิสโดยใช้แบบจำลองการแข่งขัน เกมส์ 1,3,5,7,9 และ 11 ซึ่งผู้เข้าร่วมการวิจัยเป็นนักกีฬาเทนนิส จำนวน 10 คน แบ่งออกเป็น 2 กลุ่ม คือ กลุ่มที่ 1 เป็นกลุ่มควบคุม (control (N-DHRC) ไม่ใช้เครื่องลดอุณหภูมิชนิดเร็วแบบสองมือจับในขณะพักระหว่างเกมส์ และกลุ่มที่ 2 เป็นกลุ่มที่ใช้เครื่องลดอุณหภูมิชนิดเร็วแบบสองมือจับ (DHRC) ระหว่างพักเกมส์ที่ 1,3,5,7,9 และ 11 ซึ่งผู้เข้าร่วมวิจัยทุกคนจะต้องเข้าร่วมทั้ง 2 ครั้ง ด้วยวิธีการสุ่ม ผู้วิจัยจะทำการเก็บข้อมูลด้านการตอบสนองระบบไหลเวียนโลหิต ประกอบด้วย อัตราการเต้นของหัวใจ (HR) ความดันโลหิต(BP) ประเมินความของการออกกำลังกาย (RPE) เก็บข้อมูลทุกๆ 30 วินาทีระหว่างช่วงพักเกมส์ที่1,3,5,7,9 และ 11และด้านสมรรถนะประกอบด้วยค่าความสามารถของการใช้ออกซิเจนสูงสุด และค่าความแม่นยำ เก็บข้อมูลก่อนและหลังแมตซ์จำลองการแข่งขันเทนนิส สถิติที่ใช้ในการวิเคราะห์ข้อมูล คือ Two-way repeated ANOVA และ Paired T-Test ผลการวิจัยพบว่า อัตราการเต้นของหัวใจขณะที่แข่งขันเทนนิสโดยใช้แบบจำลองการแข่งขันเกมส์ที่ 3,7 และ 11 ระหว่างกลุ่ม N-DHRC กับ กลุ่ม DHRC มีความแตกต่างกันอย่างมีนัยสำคัญที่ $p< 0.001$ (mean ± SEM; 150±1.22, 168±0.89, 184±0.65 และ 148±1.05, 163±1.01, 175±0.69 ตามลำดับ) ความสามารถของการใช้ออกซิเจนสูงสุดระหว่าง 2 กลุ่มมีความแตกต่างกัน ($p< 0.05$; mean ± SEM; 40.37±1.56, 45.68±1.18, ตามลำดับ) นอกจากนี้พบว่ากลุ่ม DHRC มีคะแนนความแม่นยำในการตีลูกหน้ามือ ที่ดีขึ้นหลังจากแมตซ์จำลองการแข่งขันเทนนิส ($p< 0.05$) สรุปผลการวิจัย พบการใช้เครื่องลดอุณหภูมิชนิดเร็วแบบสองมือจับสามารถช่วยพัฒนาการตอบสนองของระบบไหลเวียนโลหิตระหว่างการแข่งขันเทนนิสโดยใช้แบบจำลองการแข่งขัน

คำสำคัญ: ระบบไหลเวียนโลหิต / ผลของความเย็น / เทนนิส /สมรรถนะ

Abstract

The aim of this study was to investigate the effects of palm cooling using Double hand rapid cooling device (DHRC) during a 90 seconds break of game 1, 3, 5, 7, 9 and 11 in the simulated tennis match consequently, consecutive match on the cardiovascular responses and performances in male tennis player. Ten male tennis player subjects performed 2 times, separated by a week, of game repeated 12 games in the simulated match. Palm cooling (group 2) was randomly intervened using (DHRC) during 1-min rest period between game whereas subjects who had no intervention were sat quietly during rest period (group 1, control (N-DHRC)). Heart rate (HR), blood pressure (BP), rating of perceived exertion (RPE) were measured during simulated tennis match, 30 seconds break of game 1, 3, 5, 7, 9 and 11. Performances indicators were collected before and after of match. Two-way repeated ANOVA and Paired T-Test were used to analyze the data within and between groups, respectively. Results: Both groups comparison showed that there were significant different of the heart rate (HR) between N-DHRC and DHRC group for during simulate games at game 3, 7, 11 game ($p<0.001$; mean ± SEM; 150±1.22, 168±0.89, 184±0.65 and 148±1.05, 163±1.01, 175±0.69, respectively). Performances was evaluated VO2 max were detected between 2 groups ($p< 0.05$; mean ± SEM; 40.37±1.56, 45.68±1.18, respectively). The accuracy scores of the forehand ground stroke only were significantly increased after the simulated match in DHRC group ($p< 0.05$). Conclusion: Palm cooling method, treated during 1-min rest between games, improved cardiovascular responses changes during repeated games of tennis.

Keywords: Cardiovascular / Cooling Effect / Tennis / Performed

## Introduction

One strenuous activity that has intermittent bout characteristics with durations of variable duration intensities is Tennis, This activity has a duration span of 60 to 90 seconds consisting of bouts of alternating high intensities of 4 to 10 seconds and recovery bouts of 10 to 20 seconds (Girard et al., 2006). ITF rules control all recovery periods in which they have established the maximum rest times. Rest times are 20 seconds between each point, between change overs 90 seconds and between each set 120 seconds. These rest times were established in 2004 Official rules of tennis (International Tennis Federation: ITF). The duration of each match can be as long as four

hours to less than one hour in length. The sport of tennis is most often played outdoors when the temperatures are warm or hot (Kovacs, 2006). Another study done on elite road cyclists and the physiological responses effected by heat stress caused by their exercise performance was done by Tatterson et al in the year 2000. In an environmental chamber with the relative humidity at 60 percent and the temperature set at 32 degrees Celsius (HT) and 23 degrees Celsius (NT) cyclists have time trials of 30 minutes to collect data and give average results of skin temperature and sweat rates. The results were that the blood PH levels were lower ($P< 0.05$) and the blood lactate were higher ($P>0.05$) in HT compared with NT. There was a reduction of power output with highly trained men in a self- paced exercise during the last 10 minutes of exercise when the lactate levels of the blood were lower ($P<0.05$) and when there were higher levels of PH ($P>0.05$). This seems to show that decrease in performance is associated with body temperature factors rather than metabolic capacity (Tatterson et al., 2000). Core temperature at break between the games can be reduced using (12-15°C for a two-minute) cooling techniques such as water-cooled vests (Vallerand et al., 1991) (Fabiano, Paulette, Robert, & Suzanne, 2010), Cooling suits (Cheuvront et al., 2003; Fabiano et al., 2010), Hand cooling (Victoria, Michelle, Craig, Greg, & Keith, 2012), Vapocoolant sprays, and Cryo-therapy (McCarty et al., 2004; Venter, 2008), Palm cooling (Matthew, Trevor, Fabiano, Kwon, & Suzanne, 2009), Ice packs (Sinclair et al., 2009; Fabiano et al., 2010). Another method that has been recognized in practice of athletes is hand cooling methods. In 2008 Goosey and Tolfrey found that hands immersion to the wrist in water at 10°C for 10 minutes. Resulted to reductions in auditory canal temperature and improving performance in the able-bodied athletes (Goosey-Tolfrey et al.,2008). In 2009, Matthew studied about palm cooling in subjects during simulated armoured vehicle transport and reported that palm cooling reduce thermal strain in passively seated hyperthermic subject after performed three exercise bouts in a hot, dry environment (Matthew, et al., 2009).

Rapid Thermal Exchange (RTX) has been reported as an effective cooling tool in human (Hagobian et al., 2004). This device divides into 3 main parts: a) first part is Vacuum controller which works as a pump with a maximum pressure of 47 mmHg, b) second part is an attachment hose that brings cold water to body part, and c) the last part is thermal exchange chamber made by a special materials that transfer heat very

speedily (Rickart et al., 2005). Grahn et al (2008) studied about cooling via one hand using rapid thermal exchange (RTX) which improves physical performance in heat sensitive individuals with multiple sclerosis. As a result this convenient cooling method increases exercise duration by 35% of walking on a treadmill. Walker et al (2009) reveal that the RTX is ineffective at improving performance and mitigating thermal stress during high intensity intermittent exercise (Walker, Zupan, McGregor, Cantwell, & Norris, 2009). Yang et al (2009) found that this cooling device resulted in significant lower rectal temperature compared with passive cooling. Reduction in heat storage enhances human safety and performance in hot environments. In 2011, Saovieng conclude that rapid palm cooling method, applied during the 1-min rest period, improved the anaerobic peak power in Taekwondo athletes, particularly on the 3rd round. This technique offers better thermoregulatory changes during repeated exercise bouts (Saovieng, 2001). Agree with Rungchai conclude that double hand rapid cooling method, treated during 30-sec recovery period, improves anaerobic peak power, averaged anaerobic power and delays anaerobic power dropping in wrestler athletes particularly on the subsequent bout. This technique offers better thermoregulatory changes during repeated exercise bouts. The results of this study are interest for other competitive martial art sports (Rungchai et al., 2012).

However, there were no researches on the use of rapid thermal exchange (RTX) with male tennis players in order to study the effects of palm cooling using Double hand rapid cooling device to reduce physiological responses and increase performance in tennis play.

## Methodology

### Subjects

Ten male tennis players voluntarily participate in this study. The physical characteristics are tabulated in Table 1.

Table1. Characteristics of adolescent male tennis players (n=10). Values are means and standard deviations.

| Variable | Mean ± SD |
|---|---|
| Age (yr) | 21.00 ± 2.40 |
| Height (cm) | 174 ± 5.49 |
| Weight (kg) | 66 ± 5.34 |
| BMI | 19 ± 1.33 |
| Body fat (%) | 15 ± 5.36 |
| HR rest (beat/min) | 69 ± 1.75 |
| VO2 max (ml/kg/min) | 48 ± 4.41 |
| Urine specific gravity (g/ml) | 1.011 ± 0.01 |

Pre –Exercise Protocol Assessment

Standardization of the test was controlled using subject instruction as follows:

1. Hydration Status: To control hydration status, amount of drinking water was determined 24 hour before the experimental day and checking of urine specific gravity before test.

2. Subject wore their own Tennis uniforms. In addition, experiment was conducted within the same time of the day where ambient temperature and humidity were recorded. All equipments were calibrated prior to the test.

Parameters of the study

Cardiovascular system including Heart rate (record very 5 second using a Polar Accrue x Plus heart rate monitor (Polar Electro-series RS800, Kempele, Finland)) and Blood Pressure (BP).

Subjective evaluation including Thermal sensation scale (TSS), Thermal discomfort and rating of perceived exertion (RPE) was measured by Borg (1962) with score 6 to 20 (6 = Very, very light and 20 = Very, very hard).

Performance including Multi-stage fitness test (VO2 max) and Tennis skill test (Accuracy score).

Procedure

All subjects performed 2 times in climate (mean ± SD group 1 and group 2, temperature = 31.5 ± 0.92 C°, 31.3 ± 0.57 C° respectively, relative humidity = 60.6 ±

4.00%, 60.1 ± 3.21% respectively, separated by a week, of game repeated 12 games in the simulated match with 90 seconds break of game 1, 3, 5, 7, 9 and 11. Palm cooling (group 2) was randomly intervened using Double hand rapid cooling device (DHRC) during 1-min rest period between game whereas subjects who had no intervention were sat quietly during rest period (group 1, control (N-DHRC)). Cardiovascular indicators were collected during simulated tennis match, 30 seconds break of game 1, 3, 5, 7, 9 and 11. Performances including Multi-stage fitness test (VO2 max) and Tennis skill test (Accuracy score) indicators were collected before and after of match.

Statistical analysis

The statistical analysis was obtained for between - group within - group effects using Two-way repeated ANOVA and t-test respectively. The statistical significance was set at p-value less than 0.05 ($p < 0.05$).

Results

Heart rate (beats/min) (Fig.1) of both groups comparison showed that there were not significant different of heart rate between N-DHRC and DHRC at rest and simulate games at game 1 mean ±SEM 69 ± 0.52, 137 ± 1.02 beats/min and 68 ± 0.59, 137 ± 1.14 beats/min respectively. During simulate games at game 3, 7, 11 mean ±SEM 150 ± 1.22, 168 ± 0.89, 184 ± 0.65 beats/min and 148 ± 1.05, 163 ± 1.01, 175 ± 0.69 beats/min, respectively and the increased of heart rate in DHRC group was slower than that in N-DHRC group. However, a significant were influenced by palms cooling between N-DHRC and DHRC groups [$F (1.00, 9.00) = 73.09$, $p < 0.001$]. There was a main effect of number of set during simulate games [$F (14.3, 12.87) = 740.22$, $p < 0.001$]. Heart rate for both groups were still higher compared with at first games and there was significant interaction between palms cooling and games [$F (4, 36) = 25.15$, $p < 0.001$].

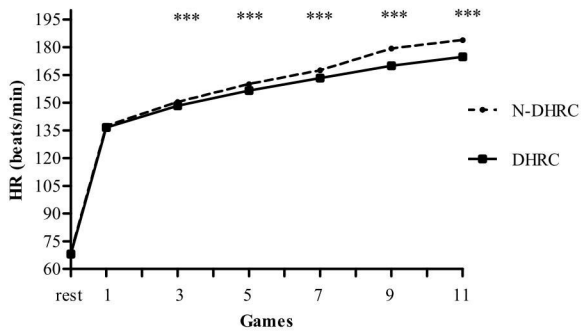

Fig1. Heart rates (beats/min) during simulated tennis match between N-DHRC and DHRC group. Values are mean and SEM. ***p<0.001 significant different between two group

Maximal oxygen uptake (VO2 max) (ml/min/kg) was estimated from baseline (Fig.2) (48±4.41) and was averaged at the end of two trials N-DHEC, DHRC, (40.37±1.56), (45.68±1.18), respectively. The VO2 max of N-DHEC and DHRC groups were significant different from baseline. Within group comparison from baseline value in N-DHEC group showed significant reduced below baseline (p<0.01). In DHRC group showed significant from baseline (p<0.01). Both groups comparison showed that there were significant different of VO2 max between N-DHRC and DHRC (p<0.05). This is test maximal oxygen uptake. We are confident about the subjects used in the test since they worked to their utmost capability and ability. From the subjects test heart rate data was gathered and an average was taken to get a median heart rate of both groups mean ± SEM; 179 ± 1.02, 182 ± 1.20, respectively.

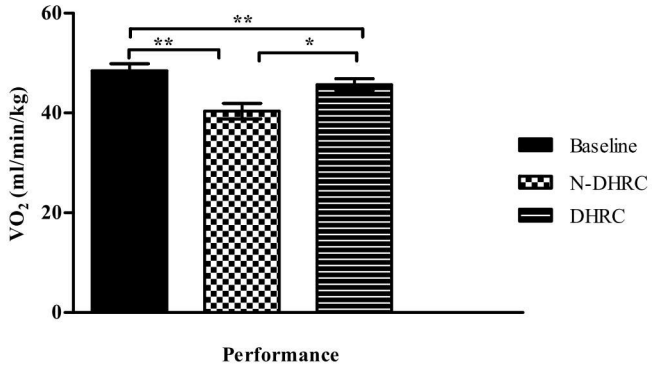


Fig2. $VO_2$ max (ml/min/kg) of baseline and after simulated tennis match within group Values are mean and SEM

*p<0.05, **p<0.01 significant different within group

Subjective evaluation

Rating of perceived exertion (RPE) (Fig.3) in both groups changed in similar pattern. Resting and simulate games at game 1 of both groups comparison showed that there were not significant different of RPE between N-DHRC and DHRC were 6.00, 12.80±0.29 and 6.00, 12.60±0.22, respectively. During simulate games at game 3, 7, 11 mean ±SEM 13.80±0.20, 16.20±0.25 ,17.90±0.10 and 13.50±0.17, 15.50±0.27, 17.20±0.20, respectively of both groups comparison showed that there were significant different of RPE between N-DHRC and DHRC groups for all game [F (1.00, 9.00) = 23.43, p < 0.001]. There was a main effect of number of set during simulate games [F

(4, 36) = 122.70, p < 0.001]. RPE for both groups were higher compared with at first games and there was significant interaction between palms cooling and games [F (4, 36) = 4.66, p < 0.05].

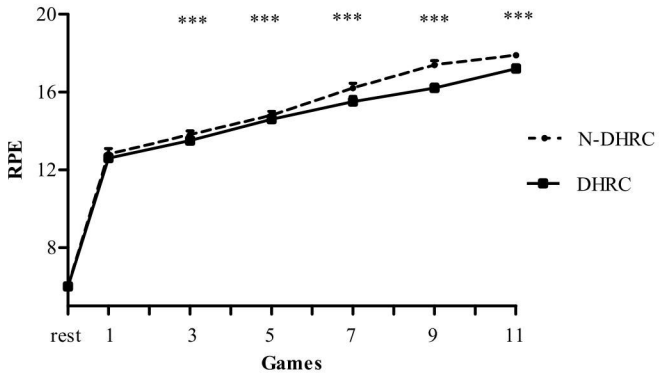


Fig3. Rating of perceived exertion (REP) during simulated tennis match between N-DHRC and DHRC group. Values are mean and SEM (Interaction effect p<0.05)

***p<0.001 significant different between two group

Discussion

In the current study, DHRC improved physiological responses and performances in male tennis player particularly on the simulated tennis match. The HR, RPE of both groups had the same pattern of change, however, the DHRC group had lower value than the N-DHRC group. These results revealed that using Double hand rapid cooling device had better heat tolerance than no using Double hand rapid cooling device ones. Conform by Grahn et al 2008 studied about cooling via one hand using rapid thermal exchange (RTX) which improves physical performance in heat sensitive individuals with multiple sclerosis. As a result this convenient cooling method increases exercise duration by 35% of walking on a treadmill. Walker et al (2009) reveal that the RTX is ineffective at improving performance and mitigating thermal stress during high intensity intermittent exercise (Walker, Zupan, McGregor, Cantwell, & Norris, 2009).

Cardiovascular variables revealed that using DHRC may effective in tennis player showed that N-DHRC group higher than DHRC group and heart rate ( as shown in Fig 1 ) indicated that DHRC group had lower heart rate than N-DHRC group was significant different in between group. Performances was evaluated VO2 max in DHRC group had lower baseline within group. The accuracy scores of the forehand ground stroke only were significantly increased after the simulated match in DHRC group.

Conclusion

Palm cooling method, treated during 1-min rest between games, improved cardiovascular responses changes during repeated games of tennis.

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