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Comparison of Anaerobic Power According to the Performance Level of Male Middle School HANDBALL Players

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Abstract

Purpose; The purpose of this study is to measure and compare the anaerobic power according to the performance level of male middle school handball players in order to analyze the difference between the well performing group and the non-performing group, while providing the basic data for improving the performance by developing the anaerobic power of the non-performing group in the future. The subjects of this study are consisted of 9 excellent handball players and 8 non-excellent players of Middle School D of Region D. The criteria for the excellent and non-excellent players provide for excellent players being those who played as starting members at the time of winning the 45th National Youth Athletic Conference in 2016 and the replacement players being the non-excellent players. As for the method of measuring anaerobic power, the Wingate test, which is the anaerobic power test for short term, and blood lactate concentration analysis were performed. The data processing of this study were analyzed using the SPSS 18.0 statistical program, and the mean and standard deviation were calculated for each item. The independent t-test was performed to examine the difference in anaerobic power between the groups, while all statistical significance levels were set to $P < .05$, respectively. The research results indicated that the excellent players were higher statistically than the non-excellent players in terms of anaerobic mean power ($p < .05$) and total work ($p < .05$) considering 1kg of weight for anaerobic power. However, even while the significant difference was demonstrated between the groups in terms of the mean power per kg of weight and total work per kg of weight, it determined that the resistance to the lactic acid generated from a high intensity workout over short term was enhanced via training by the excellent group, which did not yield a significant difference in the maximum lactic acid between the two groups. In conclusion, as for the anaerobic power variable, which has a significant influence on the handball performance, the anaerobic mean power which may be exercised by glycolysis continuously over a long term with strong resistance against lactic acid is considered to be important. It is also determined that the anaerobic energy storage method and training method need to be developed accordingly.

[Keywords] Anaerobic Power, Wingate Anaerobic Test, Blood Lactate Density, Anaerobic Mean Power, Glycolysis

1. Introduction

Handball is a game that which combines fast movements such as those of running, throwing, dribbling and shooting, as well repeated jumps, and a variety of skill unfolding movements in a stadium of 20m of goal line x 40m of sideline. In a handball game, offense is the process of dribbling and passing the ball

towards the opponent's goal area, taking shots in front of defenders, or beating the last defender with a quick pass and with fainting, then scoring with assist and making direct goal. Defenders block the offensive activity to the extent allowed by the rules, while having the purpose of interrupting and blocking the offender's pass connection thereby preventing giving the opponent a chance to score,

and connecting with the defender's goalkeeper to secure the ball and make the fast transition to offense. Therefore, a handball game may be seen as a fast paced activity at the turnover as a result of the action of attacking and defending teams near the goal area line(6m) and the free throw line(9m).

During the international handball games, the average traveling distance for 60 minutes for the first half and second half is 14 to 23m, with 70% of the total moving at a speed of 6.5 to 9m/sec, and is also said to be a sport which consumes more physical strength than any other sport. In addition, since momentary full sprint occurs frequently during the turnover, it is a competitive sport which requires both aerobic and anaerobic energy production capabilities[1][2][3].

During the exercise, the human body's energy system is divided into aerobic and anaerobic energies, depending on the oxygen dependence, while the muscular power has many variables such as motor coordination and the characteristics of muscular contraction. These variables are necessary to predict the athletes' ability to exert muscular power, which means the energy exercised per unit time, and the capacity may be said to represent the total available capacity of energy[4].

Almost all ball games in sports are reported to perform intermittent exercise, through which the intermittent rest was irregular in the development of the exercise, but the energy was supplied by the aerobic energy system which is frequently retained during the game. Therefore, handball game is a form of intermittent exercise by which aerobic exercise with a short recovery period is repeated. However, the energy supply required for playing with fast speed and agility when unfolding offense or scoring a goal in handball games may be achieved by supplying anaerobic energy, whereby anaerobic power ability is very important for handball players. Therefore, coaches and athletes in the field are much interested in the ways to increase their anaerobic power[5][6][7].

Such a power is one of the essential physical strength factors for the athletes to be successful, and is also essential for improving

their gaming performance. Such a power is commonly used to assess strength, endurance, muscular fatigue and agility. In particular, for the athletes who require short-term anaerobic power, the anaerobic power, which requires a continuous high strength and short-term power, may be deemed to be an important physical strength factor for excellent athletic performance and achievement[8][9][10]. However, while there exist many studies examining the correlation between physical strength and athletic variables, almost no studies have been conducted on the male middle school handball players.

Therefore, the purpose of this study is to analyze the differences between the groups by comparing the anaerobic power variables of the middle school male handball players and the non-excellent players, and also provide the basic data for improving their anaerobic power variables and performance.

2. Method

2.1. Subjects

The subjects of this study are 9 excellent players and 8 non-excellent players among 17 handball players of Middle School D of Region D. registered with the Korean Sport & Olympic Committee. The criteria for excellent and non-excellent athletes classified starting members as excellent athletes and replacements as non-excellent athletes for winning the National Youth Athletic Conference in 2016. The research participants voluntarily participated after listening to the explanation of the purpose and procedures of this study prior to participating in the study, and as for the participation time, it was held 2 weeks after the consummation of the National Youth Athletic Conference. The physical characteristics of the subjects participating in this experiment are as illustrated in <Table 1>.

Table 1. Physical characteristics of research subjects.

Measured item	Excellent athletes	Non-excellent athletes
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Age(year)	14.01±0.70	14.01±0.69
Height(cm)	168.88±8.24	169.03±4.36
Body weight(kg)	58.19±12.24	59.45±5.17
Muscular mass(kg)	47.11±5.52	46.85±3.64
Body fat percent- age(%)	7.41±5.07	8.48±4.16
Fat free mass(kg)	50.66±6.15	50.93±2.77
Body mass index(kg/m ²)	20.41±3.92	20.68±3.09
Personnel(people)	9	8

2.2. Measurement items and methods

1) Measurement of physical body composition

After 12 hours of meal on the day of the experiment, they relaxed for 15 to 20 minutes at the lab with empty stomach, then used the product of Inbody 3.7 biospace(Korea) to lightly wear it to avoid the maximum effect on the subject's body weight, after which the muscular mass, body fat, lean body mass, and body mass index were measured while the electrode was held in contact with the foot electrode.

2) Measurement of anaerobic power capacity

Anaerobic power capacity was measured by the Win-Gate method reported by Bar-or. The measuring time for the anaerobic power was performed for 30 seconds with the maximum pedaling exercise, and the relative load given to the individual subject was set to the body weight \times 0.075 kp to apply different relative loads for each individual. As for the measuring process, before the measurement, the athletes were seated on the bicycle's ergometer saddle, the feet were firmly fixed in pedals, then adjusted to the individual limbs, after which it was fixed while being seated, with the warm-up exercise was performed for approximately 2 to 4 minutes at approximately 80rpm, and after approximately 3 to 5 minutes of break, the exercise was performed. This exercise encouraged pedaling at the maximum possible speed, and also encouraged the atmosphere to reach a predetermined load within 2 to 4 seconds, after which it coaches and lab staffs were encouraged, then was exploded until 30 seconds after the end of the exercise[8].

3) Blood lactate density

As for the blood lactate density, it was measured at the end of the exercise phase at the end of each exercise phase 20 seconds before the end of each exercise phase by the fingertip method at rest, immediately after exercise, and at the recovery period at 1, 3, 5, 7, 10 and 15 minutes. This method used auto-lancet and capillary tube to sample a minimum of 25 μ l of whole blood, while being careful not to exceed the measurement time for the whole blood sampling. The collected blood was analyzed by using a lactic acid analyzer(YSI-1500, USA)[9].

2.3. Data analysis

The data processing method intended for this study analyzed using the SPSS 18.0 statistical program, and the mean and standard deviation were calculated for each item. Independent t-test was performed to determine the differences between anaerobic power between excellent and non-excellent athletes, while all statistically significant levels were set to $P < .05$.

3. Results

3.1. Anaerobic power

<Table 2> illustrates the results of the anaerobic power of excellent and non-excellent athletes. The peak power did not yield a significant difference ($p > .05$) given excellent athletes (620.43 \pm 141.45 watts) and non-excellent athletes (577.01 \pm 89.34 watts). The anaerobic mean power did not yield a significant difference ($p > .05$) given excellent athletes (507.66 \pm 102.98 watt) and non-excellent athlete (453.22 \pm 63.88 watt). Total work yielded no significant difference ($p > .05$) given excellent athletes (1582.12 \pm 331.32 kpm) and non-excellent athletes (1415.90 \pm 201.98 kpm).

Table 2. Comparison of anaerobic power.

Measured item	Non-excellent athletes	Excellent athletes	p
Peak power (watt)	577.01 \pm 89.34	620.43 \pm 141.45	.520
Anaerobic mean power (watt)	453.22 \pm 63.88	507.66 \pm 102.98	.292

Total power (Kpm)	1415.90 ±201.98	1582.12 ±331.32	.294
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3.2. Anaerobic power per kg of weight

<Table 3> illustrates the results of anaerobic power per kilogram of body weight of excellent and non-excellent athletes. The peak power per kg of body weight yielded no significant difference ($p > .05$) given excellent athletes (11.01 ± 1.21 watt) and non-excellent athletes (9.56 ± 0.88 watt). The anaerobic mean power per 1 kg of body weight yielded a significant difference ($p < .05$) given excellent athletes (8.82 ± 0.69 watt) and non-excellent athletes (7.60 ± 0.38 watt). The total work per kg of body weight yielded a significant difference ($p < .05$) given excellent athletes (28.35 ± 1.85 kpm) and non-excellent athlete (23.61 ± 24.11 watt).

Table 3. Comparison of anaerobic power per kg of weight.

Measured item	Non-excellent athletes	Excellent athletes	p
Peak power (watt/1kg)	9.56±0.88	11.01±1.21	.119
Anaerobic mean power (watt/1kg)	7.60±0.38	8.82±0.69*	.004
Total power (kpm/1kg)	23.61±24.11	28.35±1.85*	.003

Note: Value are mean±SD, * $p < 0.05$.

3.3. Anaerobic power for each time zone

<Table 4> illustrates the results of anaerobic power according to each time zone of the excellent athletes and non-excellent athletes. There was no significant difference in the anaerobic power of excellent and non-excellent athletes for each time zone, and across all sections ($p > .05$).

Table 4. Comparison of anaerobic power for each time zone.

Group Time	Excellent athletes	Non-excellent athletes	p
5 seconds	589.35±169.11	559.81±100.99	.706
10 seconds	584.32±110.21	526.17±85.12	.419

15 seconds	519.28±98.74	469.96±48.35	.294
20 seconds	499.40±81.34	428.47±48.41	.088
25 seconds	423.15±79.58	359.49±78.99	.216
30 seconds	424.38±139.41	359.25±75.48	.331

3.4. Comparison of blood lactate density for each time zone

<Table 5> illustrates the results of blood lactate density for each time zone of the excellent athletes and non-excellent athletes. The blood lactate density at the point of 7 minutes for each time zone yielded a significant difference ($p < .05$) given excellent athletes (6.79 ± 0.88 mMol/mL) and non-excellent athletes (5.61 ± 0.48 mMol/mL), while there was no significant difference for the rest of other sections ($p > .05$).

Table 5. Comparison of blood lactate density for each time zone.

Group Time	Excellent athletes	Non-excellent athletes	p
When rested	1.42±0.58	1.57±0.87	.317
Immediately after exercise	3.99±1.15	3.59±1.18	.564
3 minutes	6.39±0.81	6.33±0.69	.785
5 minutes	6.48±0.95	6.05±0.29	.356
7 minutes	6.79±0.88*	5.61±0.48	.048
10 minutes	6.44±0.75	5.78±1.19	.259
15 minutes	5.66±1.09	5.09±0.84	.368

Note: Unit: mMol/mL.

3.5. Comparison of maximum blood lactate density

<Table 6> illustrates the results of the maximum blood lactate density of the excellent athletes and the non-excellent

athletes. There was no significant difference ($p > .05$) given the excellent athletes ($7.18 \pm 0.88 \text{ mMol/mL}$) and the non-excellent athletes ($6.37 \pm 0.49 \text{ mMol/mL}$).

Table 6. Comparison of maximum blood lactate density.

Measured item	Non-excellent athletes	Excellent athletes	p
Maximum lactate	6.37±0.49	7.18±0.88	.179

Note: Unit: mMol/mL.

4. Discussion

This study compared the anaerobic power of 9 excellent athletes and 8 non-excellent athletes of handball of Middle School D of Region D in order to compare and analyze the anaerobic power of male middle school handball players according to their performance level.

Anaerobic power is the maximum capacity of the anaerobic process (ATP-PC and Glycolysis) to produce energy without depending on the aerobic energy supply [10], and is also highly related to the ability to exercise requiring strong movements executed under time constraint, which refers to repeating or maintaining a strong muscular contraction activity [11][12][13][14].

In this study, anaerobic power of the male middle school handball players was measured via the Wingate test. The items which the Wingate anaerobic power test measures include peak power, anaerobic mean power, total work, peak power considering the body weight of 1kg, anaerobic mean power, total work and anaerobic power for each time zone, maximum blood lactate density, and the blood lactate density for each time zone.

The anaerobic power of male middle school handball players who are excellent and non-excellent yielded significantly better in anaerobic mean power and total work considering 1kg of body weight for the excellent athletes versus non-excellent athletes. Other anaerobic power factors were not statistically significant either, yet the excellent players yielded

excellent overall results, indicating that the overall anaerobic power had an important effect on the handball performance.

In the anaerobic power, the ATP-PC system is directly influenced by lean body mass or muscular mass within the skeletal muscle, and the anaerobic power and lean body fat have a very high correlation with the behavior of the athletes requiring an explosive strength, such as power sports athletes, and so the anaerobic power has been reported to have relevance to the lean fat [15].

The peak power is the power generated by the explosive muscular contraction within 5 seconds, with energy supplied to by the ATP-PC system stored within the skeletal muscle, and as examined in the physical characteristics of the two groups of athletes, the lean body mass including the muscular mass of the two groups is almost identical, and gathering the studies of Kwon Tae-Won and Cho Mun-Shik mentioned earlier together with that of Yang Jong-Bok, there was no significant difference in the peak power caused by short-term explosive muscular contraction [4][16][17].

In the study of anaerobic power according to the gaming performance level of Taekwondo players, there was no difference between the peak power and anaerobic mean power for the elementary and middle school period, but it was reported that there was a statistically significant difference in the peak power and anaerobic mean power for the youth period of age 17 or older. That is, it is determined that the ratio of peak power and continuous anaerobic mean power may be predicted according to the period of development of muscular mass and muscular strength [18].

Since the blood lactate density is influenced by the exercise intensity, duration of exercise, meal, and glycogen concentration, etc., the interpretation of blood lactate density needs to be careful. Increases in the blood lactate density may indirectly measure the improvement of anaerobic metabolic capacity, and in terms of the relationship between exercise and lactic acid, it may also im-

prove the blood lactate density and its resistance in terms for improving the utilization of the lactate system[19]. While there was no significant difference between the groups in the mean power per kg of body weight and total work per kg of body weight, there was no significant difference in the maximum lactic acid between the two groups because it is determined that the resistance to lactic acid is improved, which is generated over a short term of high intensity via training by the excellent group. In addition, the non-excellent group enters the recovery phase in approximately 3 minutes after the exercise, whereas the excellent group may be seen to continued to increase little by little up to 7 minutes. It is determined that the ability to mobilize energy generated by the anaerobic mean power, that is, lactate system, representing muscular endurance by the excellent group, is excellent.

The scoring activity which determines the outcome of handball games is ultimately the strong jump shot and diving shot. In addition, in order to create such a scoring situation, it is only possible by continuing passing, dribbling, and tactical movements in the areas where there is no ball. The anaerobic mean power per 30 kg of body weight has been reported to be correlated with 30 meters of running, which is thought such that in the handball games, it is necessary to move quickly and repeatedly for a distance which is less than 30 meters when moving and defending each time. It is also thought that such a movement is performed by anaerobic mean power by anaerobic glycolysis. Such movements are not caused by the ATP-PC system due to the explosive muscular contractions over a short term, yet are almost dependent on the lactate system since they produce energy in the situations where oxygen is insufficient [20][21].

Therefore, as for the gaming performance capability of the youth's handball, the anaerobic mean power, which should be continuously exercised as much as the importance of peak power due to the short term explosive muscular contraction such as shooting movement or full sprint, is also important, and it is also determined that the anaerobic energy storage method and training method need to

be developed accordingly.

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