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The Comparison of Electromyography (EMG) During Blocking in Elite Sepaktakraw Athletes

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ABSTRACT

Background: Blocking is a major indicator of the sepaktakraw game's results. The analysis of muscle activity involved in blocking provides coaches or amateur athletes with additional information about the importance of muscle groups that influence effective blocking. **Objective:** This research aimed to compare the maximum voluntary contraction (MVC) during blocking elite sepaktakraw athletes in different muscles. **Methods:** This research is a cross-sectional study design with fourteen male sepaktakraw athletes (striker position) in the Sepaktakraw Thailand League, aged 20-40 years. All participants completed an informed consent by the ethical committee of Thailand National Sports University (TNSU-SCI 043-2566), and were placed electrodes on five muscle groups, including the rectus abdominis (RA), left rectus femoris (LRF), left gastrocnemius medialis (LGM), right rectus femoris (RRF) and right gastrocnemius medialis (RGM). The collection of blocking is divided into 3 phases: takeoff, flight and landing. **Results:** The LGM had the highest and was significantly with RA in takeoff phase and landing phase ($P<0.05$), RGM had the highest in flight phase and significantly different with takeoff ($p<0.05$). Moreover, RA during flight and landing significantly differed from takeoff ($p<0.05$). **Conclusion:** The information this research will help coaches and amateur athletes understanding the blocking in elite athletes. Additionally, they need a specific muscle training program.

Key words: Electromyography, Blocking, Different, Muscles, Elite, Athletes

INTRODUCTION

In sepaktakraw, the blocking skill involves a player jumping and trying to get their body above the net to prevent attacks (Sheppard et al., 2009). Blocking is the first defensive line a team attempts to counter-attack as a possible way to achieve direct results (Mesquita & Cesar, 2007). Effective blocking depends on jumping forcefully to raise the center of mass to reach the greatest possible height (Ficklin et al., 2014). According to the professional sepaktakraw game, a team consists of three separate playing positions: server, feeder and striker. Most points are scored by striking over the net with the sunback and rolling kick (Jawis et al., 2005). Blocking plays an important role in hindering performance or creating concern for the opponent (Giatsis et al. 2015). Successful blocking of the winning team was approximately 62% different with the losing team (Udomtaku & Konharn, 2020). There are many different methods of blocking according to the player's aptitude such as blocking with the head, the back, and the legs and body.

Blocking with the legs and body is the most popular way to defend because it can provide a large space on the net (Prani, 1996). Athletes move involves running a few steps forward and single-leg jumping. The technique of single-leg jumping with the other leg straight over the net and twisting the body back. That is accompanied by inertia forward movement (Zahradnik et al., 2016). Net sports emphasise the importance of muscle strength in jumping because frequently skills (Bunn et al., 2020). Muscle strength is important to blocking (Kitamura et al. 2020). Vertical jump is a basic blocking (Borras et al. 2011). Which has to do with the strength of the lower extremity muscles (Voelzke et al., 2012). Muscle activity can be detected using electromyography (EMG), an indirect method of measuring motor unit action potential (MUIP) that is trans to muscle work. EMG can be a measurement of muscle performance (Konrad, 2005).

EMG in each phase of the blocking is important in terms of each muscle activated for efficiency in blocking. Previously, the research only focused on general muscle strength training, and no study has ever used electromyography (EMG) for sepaktakraw blocking. The unresolved question is: How do muscles work during blocking of elite sepaktakraw athletes? An analysis of the muscle activity associated with the blocking phase allows coaches or amateur athletes to gain additional information about the importance of muscle groups that influence effective blocking; takeoff, flight and landing. Therefore, this research aimed to compare

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the muscle activation of blocking in elite sepaktakraw athletes.

METHODS

Participants and Study Design

Fourteen male sepaktakraw athletes (striker position) had purposive selected from 7 clubs in the Sepaktakraw Thailand League 2022-2023 (Figure 1), aged 20-40 years old and there were no injuries in the lower limbs; ankle, knee, hip and thigh (Kubo et al., 2016). The participant being severely injured or voluntarily withdraw would be excluded from this research. All participants completed an informed consent by the ethical committee of Thailand National Sports University (TNSU-SCI 043-2566).

Instruments

The EMG signal was recorded using the BTS-FREEEMG (BTS-FREEEMG1000; BTS Bioengineering, Milan, Italy). Adhesive hydrogel surface electrodes were placed on the selected muscles (Kendall, H124SG electrode, Dublin, Ireland). To prevent peeling or foreign objects from interfering with the EMG signal while data collecting, all electrodes are secured to the skin using sports strapping tape (Tigerplast, JACK CHIA Industries, Thailand). Additionally, the trials were recorded by a Canon EOS-550D camera in the center of the court to obtain a perfect view (Canon, Tokyo, Japan). The video data was downloaded via Kinovea 0.8.15 (www.kinovea.org). All participants blocking on the rubber takraw court in competitions certified by the ISTAF (Marathon Co, Ltd, Thailand). The net used is of standard height in 155 cm (Marathon Co, Ltd, Thailand).

Procedures

Before the data collected one day, all participants were informed about the purpose of the research and the data collection process. The participants were informed about the purpose of the research and the data collection process and signed a written consent. The short survey about age and experience were completed.

Participants were asked to block with their legs and body only. After that, participants measured weight, height and body fat. All data in the trials were collected simultaneously using a virtual location at the Sports Science Center of Thailand National Sports University-Sukhothai Campus as shown in Figure 2.

On the day of data collection, all participants were wearing sport suits, the same actual competition match. The placement of EMG electrodes was cleaned skin with alcohol. The locations of electrode placement obtain from consulting with national sepaktakraw coaches and sports scientists. The electrodes were placed on five muscle groups, including the rectus abdominis (RA), left rectus femoris (LRF), left gastrocnemius medialis (LGM), right rectus femoris (RRF) and right gastrocnemius medialis (RGM). The EMG signals were set to a sampling rate of 1,000 Hz per channel (Ives & Wigglesworth, 2003).

The blocking is divided into 3 phases: Takeoff, the body jumps on one leg to carry the body into the air. In flight, the body is above the net to create space to block the opponent by leg and body and the landing is when the foot touches the ground (See Figure 3).

Data collection began at 3:00 p.m. Once the subject is fitted with the electrodes, they warm up and stretch for 5-10 minutes, paying particular attention to the ligaments in their lower limb joints. To feel familiar with the tools and be ready for testing, participants were asked to jump and jogging. Performed a total of blocking by taking two running steps from the side of net and blocking with one leg and trying to keep body in air as long as possible. A forty-second rest period was used. The participants who injured provide first aid for five minutes. If they are unable to continue, they are removed from the data collection.

The EMG data was downloaded via BTS EMG-analyzer Software (version 2.9.41.2 for Windows, BTS Bioengineering, Milan, Italy). The signals were filtered 10–500 Hz with a Butterworth filter (Majid et al. 2018; Wang et al. 2021) and time of duration is 100 ms, calculating maximum voluntary contraction (MVC*)*. The normalize EMG with the root mean square (RMS) value each muscle during the blocking to the MVC report (calculations from the start to end in each blocking phase). The video data was downloaded via Kinovea 0.8.15 (www.kinovea.org) to blocking height and flight time.

Statistical Analysis

The statistic and data analysis used the Statistical Package for the Social Sciences (SPSS) 25 software. Mean and standard deviations were expressed for the baseline characteristics. Differences in MVC with different muscle groups (RA, LRF, LGM, RRF and RGM) were analyzed using a one-way analysis of variance (ANOVA) and the Bonfereroni multiple comparison post-hoc test. $p<0.05$ was set as significant.

RESULTS

In table 1 shows that baseline characteristics of fourteen male strikers (aged 26.51±4.25 years old, weight 68.75±5.8 kg, height 175.34±7.8 cm, body fat 13.12 ±4.13%) with 4.25±1.56 years of Sepaktakraw Thailand League experience, height of blocking 173.7±2.13 cm and 0.68 ±0.15 s in flight time.

In table 2 shows that the mean (M), standard deviation (SD) and *F*-value for takeoff, flight and landing across muscle groups indicated significant difference on takeoff with $F(4,65) = 119.99$, $p<0.01$, flight with $F(4,65) = 38$, $p<0.01$ and landing with $F(4,65) = 40.862$, $p<0.01$. The MVC of LGM in takeoff had the highest and was significantly different from LRF and RA ($p<0.05$). Flight phase found that RGM had the highest followed by LGM, which was significantly different from LRF ($p<0.05$). While landing was the highest from LGM followed by RGM, RRF and LRF respectively and was significantly different from RA ($p<0.05$).

In table 3 shows that the F-value for muscle groups across phases of blocking indicated a significant difference $p<0.01$ on RA with $F(2,39) = 27.538$, LGM with $F(2,39) = 18.962$

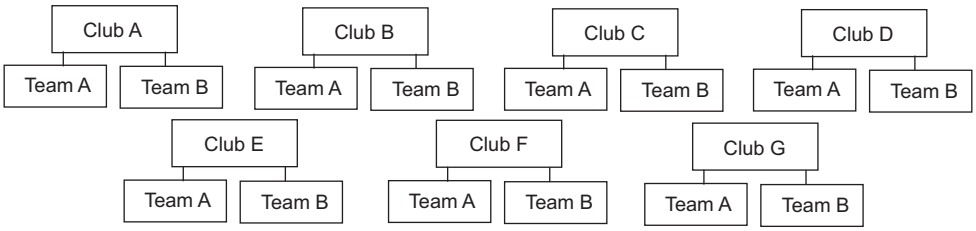

Figure 1. The diagram of the teams in each club in the Sepaktakraw Thailand League 2022-2023

Figure 2. The diagram of simulate location of blocking test. BTS-FREEEMG and camera were set in the front of the participants

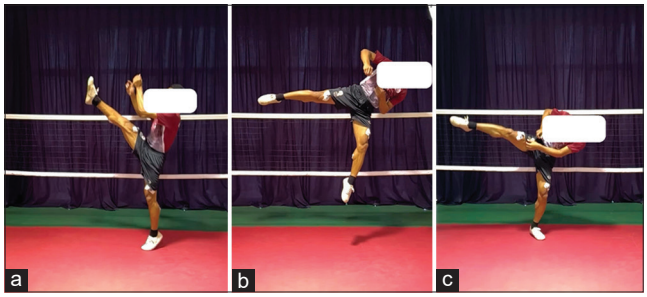

Figure 3. The phase of blocking; takeoff (a), flight (b), landing (c)

and RRF with $F(2,39) = 19.232$. While the RGM significant difference $p<0.05$. The MVC in RA during flight was the highest, followed by landing, which was significantly different from takeoff ($p<0.05$). Moreover, RGM in flight was significantly different with takeoff ($p<0.05$).

DISCUSSION

The results of the present studies provide insights into the physical profile of strikers that their average age was 26.51±4.25 years because their position is linked to jumping, hitting, and blocking, which put them at risk of injury (Palao et al., 2014), with an average experience of 3.25±1.56 years in the Sepaktakraw Thailand League, the average height of 175.34±7.8 cm tall, and light body weight because they need to be flexible, able to rolling kick and blocking above the net with an average height of 173.7±2.13 cm possibly lasting 0.68 ± 0.15 s Most athletes used their right leg to block. The important thing the blocker must face is moving forward quickly from the side of the net to the appropriate takeoff point, and jumping up into the air (Xu, 2020).

During the takeoff, the MVC is at the LGM, which means bocking when athletes jump on the left leg into the air, unlike the counter movement jump in volleyball (Berriel et al., 2021). The blocker prepares to move toward the center of the net by taking two steps and jumping (Millan-Sanchez et al., 2019), with their knees along with raising the right leg into the air and stretching forward. Therefore, RGM and RRF are contracted to create centrifugal force and increase height before jumping, and then put their force to jump up.

The flight phase is very important for blocking because this is the moment when the athlete tries to use his whole body to block the ball from the opponent's attack (Hasan & Abdul, 2021). The MVC is at RGM, followed by LGM. The modern block may be different from the past, when blocking was used with the back. This shows that elite sepaktakraw athletes today prefer to use their right leg to stretch over the net. Therefore, the right leg's gastrocnemius must be contraction to maintain the posture, including, leaning back so that it is parallel to the net and contracting RA. Additionally, this increases the blocking area to gain height and most of the time in the air. When comparing the air time, it is similar to the blocking of world-class volleyball, which is a double-legged jump (Benelguemar et al., 2020), in order to be difficult for the opponent attack may cause the players to make mistakes by themselves (Caldeira et al., 2024).

After blocking, the body quickly landed on the ground. The studies showed that LGM put maximum force to absorb from single-leg block jumps with inertia of body weight, causing the feet not to fall down to the ground. Then, the left foot usually touches the ground first. Going down to the ground uses tips of toes and distribute the force to the GM to relieve the weight of the body along with bending your knees (Mokhtarzadeh, et al., 2013), squatting down by keeping your eyes on the ball or landing area (Schmidt, 2015). Tightening muscles and applying force to your RGM and RA helps maintain landing posture, preventing right from falling after going up to block the ball (Lida et al., 2012), and getting prepared to play immediately. Good balance be advantageous if the block is made, and the ball is in the defensive area. The team can immediately attack the opponent back (Lobietti et al., 2010).

Muscle functioning in different blocking phase, it was found that the LRF and RRF were not different MVC. This shows that both muscles are important during vertical jumping when working with gluteus maximus, gastrocnemius, and transferring power from the knees to the hips (Robertson et al., 2008). Even though it is a single leg jump on only the left leg; it seemed that RRF exerted more force in all phases than LRF. This may be the blocking stance that uses the right

Table 1. Baseline characteristics

	Aged (years)	Experience in League (years)	Weight (kg.)	Height (cm)	Body fat (%)	Height of blocking (cm)	Flight time (s)
Strikers (n=14)	26.51±4.25	4.25±1.56	68.75±5.8	175.34±7.8	13.12±4.13	173.7±2.13	0.68±0.15

Table 2. The MVC of difference muscle groups in the phase of blocking

Phase of blocking	Muscle										F (4,65)	η^2
	RA		LRF		LGM		RRF		RGM			
	M	SD	M	SD	M	SD	M	SD	M	SD		
Takeoff	0.241	0.066	0.456	0.052	0.744	0.047	0.467	0.085	0.512	0.059	119.99**	0.881
Flight	0.507	0.062	0.433	0.055	0.632	0.066	0.541	0.031	0.683	0.11	38**	0.71
Landing	0.393	0.095	0.468	0.068	0.721	0.031	0.611	0.054	0.641	0.112	40.862**	0.715

(**p<0.01)
Rectus abdominis (RA), left rectus femoris (LRF), left gastrocnemius medialis (LGM), right rectus femoris (RRF) and right gastrocnemius medialis (RGM)

Table 3. The MVC of muscle groups in different phases of blocking

Muscle	Phase of blocking						F (2,39)	η^2
	Takeoff		Flight		Landing			
	M	SD	M	SD	M	SD		
RA	0.241	0.066	0.507	0.062	0.393	0.095	27.538**	0.586
LRF	0.456	0.052	0.433	0.055	0.468	0.068	1.275	0.062
LGM	0.744	0.047	0.632	0.066	0.721	0.031	18.962**	0.494
RRF	0.467	0.085	0.541	0.031	0.611	0.054	19.232**	0.496
RGM	0.512	0.059	0.683	0.11	0.641	0.112	3.292*	0.143

(*p<0.05), (**p<0.01)
Rectus abdominis (RA), left rectus femoris (LRF), left gastrocnemius medialis (LGM), right rectus femoris (RRF) and right gastrocnemius medialis (RGM)

leg to lift first from the start until blocking over the net and into the area for the posture to be maintain.

LGM has the high signals because it exerts the force of jumping to carry the body to escape gravity over the net with a height of 1.55 m. The force of the jump starts at stretching of the sole of the foot through the ankle to exert force on the gastrocnemius (Martinez et al., 2002). Power is transferred back from the LRF to the hips during takeoff (Kakihana and Suzuki., 2001). The LGM also exerts force on landing similar to takeoff. The force to the ankle is transferred to the gastrocnemius. In addition, the strength of gastrocnemius it also reduces the load on the ACL which possibly causes danger (Morgan et al., 2014).

Meanwhile, RGM works a lot in the flight phase because elite athletes block with their right leg and body, RGM contracting is a force to support the leg raised above the net by stretching the toes parallel to the net as much as possible. Through the force applied to the thighs and hips in flight (Liebenson et al., 2009). The posture cannot be maintained when blocking and landing in a safe area, and the player must be prepared to play the next ball without the RGM force (Geng, 2024).

The interesting point in this research is that RA worked the most in flight and landing phase. In sepaktakraw requires sudden movements in all directions, jumping and blocking (Purwanto, 2022). The strength of core muscle is important for maintaining stability whether it is moving or not (Hibbs et al., 2008). RA will be stimulated from the start of the jump, but it works most while in the air since when blocking, athletes are bending back to create blocking space and much the flight time. While landing that requires balance and strength of trunk. RA functions increased before feet touched the ground to receive contact and prevent falling (Lin et al., 2021).

In sepaktakraw, blocking is not only a defensive skill, it is also successful blocking play for the team winning. Therefore, athletes must practice and improve the ability of muscles in each part appropriately. Many countries promote research in sepaktakraw to be top in world ranking. These findings provide valuable information that supports coaches, trainers, and athletes in training, especially amateur athletes in order to improve their potential and be comparable to the elite athletes.

Limitation

According to the findings, in-depth information about muscle activated during blocking in elite Sepaktakraw athletes, however, some limitations must be considered for future research as well. Firstly, there should be collected data while actual blocking ball situations from opposing athlete's strikes because demonstrative situations may not be

able to motivate the athletes with full potential. Secondly, in this research, only the center area of the net was blocked. In the future should be added both close body and distance blocking should be added. Finally, although the EMG was placed on five muscle locations in this research, there may be limitations in the upper limb that also play a part in blocking. Researcher should be increased muscle positions to cover the entire body to get more information.

Strengths and Practical Implications

Despite the limitations, this research contributes to the depth information of muscle group activity during blocking in elite athletes. That is more than relying on only theoretical assumptions. This will lead to the design of training for amateur athletes. It is important to emphasize the specific muscle groups that efficiency blocking. (e.g., height of body in air, appropriate body position and flight time).

CONCLUSIONS

This research revealed that EMG occurring in the muscles of elite sepaktakraw athletes during blocking with a blocking posture that used legs and body, which LGM was most active during jumping and landing. In flight phase, the strength of the RA and RGM were required to maintain posture including defensive space over the net. All of the information this research provide will help coaches and amateur athletes understand the blocking of elite athletes and that they need specific muscle training programs.

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DATA AVAILABILITY

The data used analyzed in the electromyography (EMG) during blocking study are available from the corresponding author on reasonable request.

AUTHOR'S CONTRIBUTION

K.U.: Conceptualized the study, study design, data collection, data analysis, writing original draft and editing. P.W. participated in the literature review, study design and editing.

ETHICAL APPROVAL

The study was approved by ethical committee of Thailand National Sports University (TNSU-SCI 043-2566). The procedures of the study was explained to all the participants and collected the data with the guidelines of the Declaration of Helsinki for human research.

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