Nur Ikhwan bin Mohamad . <nur.ikhwan@fsskj.upsi.edu.my>

Re: BWF final report

3 messages

Adrian Lees <a.lees4@btinternet.com> Tue, Apr 26, 2016 at 11:29 PM
To: "Nur Ikhwan bin Mohamad ." <nur.ikhwan@fsskj.upsi.edu.my>
Cc: Ian Wright <i.wright@bwfbadminton.org>

Dear Ikhwan

Thank you for your final report. This email is acknowledgement of receipt and acceptance of this report. I hope this allows you to finalise matters at your University.

You submitted two reports. The second was not identified as an area of research in your original application, and has not subsequently been updated. It is not possible for BWF to accept this report as it is not one approved and financed by BWF. However, I am able to acknowledge the satisfactory nature of this study and BWF would encourage you to submit it for publication in a suitable outlet. For this study there is no requirement to refer to BWF financial support.

I hope this clarifies the status of both reports. Thank you for your contribution to BWF research activity and I wish you well in your continuing research programmes.

Yours sincerely

Adrian Lees
BWF Sports Science Research Project Coordinator

Nur Ikhwan bin Mohamad . <nur.ikhwan@fsskj.upsi.edu.my> Wed, Apr 27, 2016 at 5:09 AM
To: Nurul Ain Sahar <ain.sahar@upsi.edu.my>
Cc: Jeffrey Low Fook Lee <jeffrey@fsskj.upsi.edu.my>, Sham Jeffry <shamjeffry@gmail.com>, Ali Md Nadzalan <ali.nadzalan@fsskj.upsi.edu.my>, Mohd Zaiham Izwan bin Zainudin <zaiham_izwan@upsi.edu.my>, Zulkapli bin Mohd Junid <zulkapli@upsi.edu.my>

Salam,
Dilampirkan pengesahan tamat penyelidikan daripada pemberi dana BWF yang baru diterima.

Terima kasih,

Ikhwan

[Quoted text hidden]
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Assoc. Prof. Dr. Nur Ikhwan Mohamad PhD
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jeffrey@fsskj.upsi.edu.my <jeffrey@fsskj.upsi.edu.my> Wed, Apr 27, 2016 at 7:15 AM
To: "Nur Ikhwan bin Mohamad ." <nur.ikhwan@fsskj.upsi.edu.my>

Noted with thanks.

Sent from my iPhone
[Quoted text hidden]

LOWER LIMB MUSCLE ACTIVITY, KINEMATICS AND KINETICS ASSESSMENT AMONG RECREATIONALLY ACTIVE BADMINTON PLAYERS

MEOR SHAMSUL BIN MAHFUDZ JEFFRY, NUR IKHWAN MOHAMAD, ALI MD. NADZALAN, JEFFREY LOW FOOK LEE

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ABSTRACT

Introduction: This study was conducted to determine the muscle activity, kinematics and kinetics of lower limb during right and left leg forward lunges movement. **Methods:** Fifteen recreationally active badminton players, aged between 18 to 30 years old were recruited for this study. A tri-axial force plate was used to measure kinematics and kinetics output during the lunge movement. Electromyography was used to measure muscle activity of both leading and non-leading leg during right leg lunges (RL) and left leg lunges (LL) movement. **Results:** Results showed during RL, no significant differences were found between all the muscles tested, $p > 0.05$ on the leading leg while EMG activity of biceps femoris was significantly greater compared to gluteus maximus, $p < 0.01$ on the non-leading leg. During LL, EMG activity of biceps femoris was significantly greater compared to gluteus maximus, $p < 0.05$ on the leading leg while EMG activity of rectus femoris was significantly greater compared to gluteus maximus, $p < 0.01$ and gastrocnemius, $p < 0.05$ on the non-leading leg. Besides that, results showed the EMG activity of rectus femoris ($p < 0.01$) and gluteus maximus ($p < 0.05$) of the right leg during RL were significantly higher compared to left leg during LL. Results also showed the EMG activity of rectus femoris of the left leg during RL were significantly higher compared to right leg during LL, $p < 0.05$. The impulse produced by left leg (M = 563.95 Ns ± 22.45 Ns) was slightly greater compared to impulse produced by right leg (m = 580.71 ± 32.60), however, no significant difference was found, $p > 0.05$. The velocity produced with right leg was significantly faster (M = 44.04 m/s ± 9.74 m/s) compared to velocity produced with left leg (M = 74.68 m/s± 13.53 m/s), $p < 0.05$. **Discussion:** The current study showed the biceps femoris was the most dominant muscle during lunges followed by gastrocnemius, rectus femoris and gluteus maximus. This was in contrast to previous findings and traditional believe that quadriceps muscles were the primary muscles in lunges movement. **Conclusion:** It is suggested that lunges accompanied by muscle activation assessment and kinetics output measurements to be used for a more accurate assessment and in order to help determine asymmetry and specific muscles ability apart from in-court agility among badminton players.

Keywords: *electromyography, impulse, lunges, velocity of movement*

Introduction

The popularity of badminton has risen since its inclusion as an official sport in the 1992 Olympic Games in Barcelona. Current rules of badminton state that a match consists of the best of 3 games, with the first player scoring 21 points will win the game. While the sport has been played for decades since 18th century, not many scientific researches especially in relation to lower limb kinematics and kinetics assessment have been conducted in badminton, compared to other sports such as soccer, athletics and tennis. Current search on major database indicate almost no proper and high-impact studies have been performed on lower limb kinematics and kinetics of elite badminton players.

Studies on profiling of badminton players physical characteristics focused on anthropometry and physiological element (Campos, Daros, Mastrascusa, Dourado, & Stanganelli, 2009; Heller, 2010; Majumdar et al., 1997; Wonisch, Hofmann, Schwaberger, von Duvillard, & Klein, 2003), with less or no attempts examining the the kinematics and kinetics components. As muscle strength means the ability to exert force (Impellizzeri, Rampinini, Maffiuletti, & Marcora, 2007; Kroemer, 1970), strength training can be referred as the training of enhancing force development and other related kinematics and kinetics. Thus, without sufficient kinematics and kinetics data of the trained body region, the strength and conditioning coach or trainer will experienced difficulty in training program design, development, performance prediction and monitoring of training effect (Abernethy, Wilson, & Logan, 1995; Cronin & Henderson, 2004; Cronin & Owen, 2004; Jidovtseff et al., 2008).

Muscular endurance accompanied by maximal and explosive muscle strength are important for badminton players due to the nature of the sport with rapid and fast movement characteristics for skills execution (Andersen, Larsson, Overgaard, & Aagaard, 2007; Cabello, Padial, Lees, & Rivas, 2004). Therefore excellent strength capabilities are highly needed for badminton players. With that in mind, the next question of interest for strength and conditioning coaches is the type of exercises that should be incorporated into daily training regime and included in monitoring assessment. Observations on typical movements performed by badminton players show the lunge movement being performed frequently. Lunges has been regarded as one of the functional exercises for the development of lower-limbs (Keogh, 1999), with muscles activated in a full lunges performance includes gluteals, hamstring, and quadriceps muscles (Irish, Millward, Wride, Haas, & Shum, 2010; Pincivero, Aldworth, Dickerson, Petry, & Shultz, 2000). The focal point here is that, with lunge movement been identified as one of the main movement of choice by badminton players, it will seems more logical to use lunges exercise as one of the type of exercises in a strength training program for them. With the movement being administered in training and competition, the next logical part is to also use it in training effect monitoring assessment.

However, the next question arise is how to measure the lunges quantitative and qualitatively? As indicated earlier, measurement of kinematics and kinetics variables provide objective measurement of strength capabilities, the use of any devise that can measure those variables accurately with high reliability and validity is required. The most accurate and highly reliable kinematics and kinetics measurement devise which is based on ground reaction force is the force platform, which has been extensively used in many laboratory set-up to produce any variables of interest that derives from ground reaction force measured (Cormie, Deane, & McBride, 2007; Hori et al., 2007; Lephart, Ferris, Riemann, Myers, & Fu, 2002). Force platform provide the easiest but still accurate although not the cheapest in measuring kinematics and kinetics variables, in comparison with other methods including equation calculation methods (Hertogh & Hue, 2002). Four methods are used to measure mechanical power and produce other kinematics and kinetics variables; i) utilization of displacement data alone via position transducers or any other similar devise, ii) using the vertical ground reaction force (VGRF) which derives from force platform, iii) a combination of VGRF and displacement data from both such as force platform and position transducers, iv) using an accelerometer system (Comstock et al., 2011; Dugan, Doyle, Humphries, Hasson, & Newton, 2004; Hansen, Cronin, & Newton, 2011). As lunge is performed by executing movement force on the ground, the most appropriate equipment is the force plate, considered as the gold standard measurement for VGRF.

There is a paucity of research conducted in relation to scientific strength assessment of badminton players. The issue brought forward in this study was important in the sense that, it would introduce a more appropriate specific assessment method during strength training monitoring, with regards to the closeness of the assessment used to actual movement pattern.

Therefore, the aims of this study were to determine the kinematics and kinetics during RL and LL and muscle activity of both leading and non-leading leg during both RL and LL among badminton players.

Methodology

Participants

Fifteen recreationally trained badminton players (21.13 ± 2.03 years old) were recruited for this study. The number of participants were based on the number of players that were currently in active training with either state or club team at the time of data collection. This study was approved by the research committee from Research Management Centre, Sultan Idris Education University.

Equipment

All lunge tests were performed on a triaxial force platform (BP400600HF-2000, AMTI Inc., USA), with a video recorder (Sony Electronics Inc., Tokyo) to record the movement patterns. Muscle activation during the performance was assessed using a wireless electromyography (EMG) system (Trigno, Delsys, USA). Four EMG electrodes were placed on each side of leg at rectus femoris (RF), gluteus maximus (GM), biceps femoris (BF) and gastrocnemius (GAS).

Procedures

The session commenced with a briefing from the researcher on background of the study and testing procedures involved. Briefings included movement technique demonstrations. Participants were provided a participation consent letter to be read and voluntarily signed once all doubt and questions arise were answered by the researcher. Participants were reminded that they were allowed to quit the study at any time during any phase of the study voluntarily. The participants' body weight, height and leg length were measured prior the warm-up. A guided warm-up consisted of 10 m run (12 repetitions), forward lunges (10 repetitions), bodyweight squat (10 repetitions), and forward lunges with hands cross over the chest (10 repetitions with 80 % raising up movement back to starting position).

A demonstration of proper lunge technique was again demonstrated prior to participant's trial test. Participants were given five trials to familiarize themselves with the lunges test movement. Correction were made wherever necessary by the researchers in order to ensure proper movement execution, and thus to ensure all participants were performing the movement pattern with the best physical capabilities that they have, and not limited by lack of knowledge of the specific movements. Thirty seconds rest period were given after the last trial before the start of the first actual test.

All participants were given two trials of two repetitions each leg, for each movement/exercises, with the average performance were counted for marks accordingly. During the testing, all movement were recorded and analyzed.

Data Analysis

All variables of interest (impulse and velocity) were collected from force plate while the muscle activity was analyzed using the Delsys software.

Statistical Analyses

Descriptive analysis was used to measure the physical characteristics (age, bodyweight and height), mean and standard deviations of score. Shapiro-Wilk test was used to test the normality of data. One-way ANOVA was used to analyze the differences of muscle activity of rectus femoris, gluteus maximus, biceps femoris and gastrocnemius during RL and LL for both leading and non-leading leg. Independent t-test was used to analyze the differences of muscle activation between right and left leg. An alpha level of 0.05 was set for significant levels for all statistical tests.

Results

Table 1: Physical characteristics

Variables	**Mean ± SD**
Age (years)	21.13 ± 2.03
Body mass (kg)	65.55 ± 12.15
Height (m)	1.66 ± 0.06

Table 1 : Physical characteristics of participants recruited.

Table 2: EMG activity of right leg during RL

Muscles	**Value (%)**
RF	63.42 ± 44.09
GM	8.49 ± 6.37
BF	64.15 ± 68.17
GAS	79.03 ± 134.54

Table 2: EMG activity of muscles tested on the right leg during RL. Results showed no significant differences between all the muscles tested, $p > 0.05$.

Table 3: EMG activity of left leg during RL

Muscles	Value (%)
RF	15.94 ± 5.91
GM	5.97 ± 4.30 [c]
BF	34.82 ± 36.08 [b]
GAS	21.66 ± 20.51

[b] = significantly different from gluteus maximus
[c] = significantly different from biceps femoris

Table 3: EMG activity of muscles tested on the left leg during RL. Results showed the EMG activity of biceps femoris was significantly greater compared to gluteus maximus, $p < 0.01$.

Table 4: EMG activity of left leg during LL

Muscles	Value (%)
RF	14.09 ± 5.41
GM	4.50 ± 3.02 [c]
BF	47.17 ± 70.95 [b]
GAS	24.67 ± 23.28

[b] = significantly different from gluteus maximus
[c] = significantly different from biceps femoris

Table 4 : EMG activity of muscles tested on the left leg during LL lunges. Results showed the EMG activity of biceps femoris was significantly greater compared to gluteus maximus, $p < 0.05$.

Table 5: EMG activity of right leg during LL

Muscles	Value (%)
RF	34.07 ± 26.51 [b,d]
GM	4.97 ± 7.1 [a]
BF	17.41 ± 23.81
GAS	14.80 ± 10.71 [a]

[a] = significantly different from rectus femoris
[b] = significantly different from gluteus maximus
[c] = significantly different from biceps femoris

Table 5: EMG activity of muscles tested on the right leg during LL lunges. Results showed the EMG activity of rectus femoris was significantly greater compared to gluteus maximus, $p < 0.01$ and gastrocnemius, $p < 0.05$.

Table 6: EMG activity of right and left leg as leading leg

Muscles	Percentage Comparison
RF	Right leg > left leg *
GM	Right leg > left leg *
BF	Right leg > left leg
GAS	Right leg > left leg

*significant at p-value < 0.05
**significant at p-value < 0.01

Table 6 : EMG activity muscles tested on the right and left leg as leading leg during RL and LL. Results showed the EMG activity of rectus femoris ($p < 0.01$) and gluteus maximus ($p < 0.05$) of the right leg during RL were significantly higher compared to left leg during LL.

Table 7: EMG activity of right and left leg as non-leading leg

Muscles	Percentage Comparison
RF	Right leg > left leg *
GM	Left leg > right leg
BF	Left leg > right leg
GAS	Left leg > right leg

*significant at p-value < 0.05

Table 7 :EMG activity muscles tested on the right and left leg as non-leading leg during LL and RL. Results showed the EMG activity of rectus femoris of the left leg during RL were significantly higher compared to right leg during LL, $p < 0.05$.

Table 8: Impulse and velocity produced during lunges with right and left leg

	Impulse (Ns)		**Velocity (m/s)**	
	Mean	SD	Mean	SD
RL	563.95	22.45	44.04	9.74
LL	580.71	32.60	74.68	13.53
%diff	2.97%		69.57%	
sig	0.307		0.01*	

Table 8: The impulse produced by left leg (m=563.95 Ns ± 22.45 Ns) was slightly greater compared to impulse produced by right leg (m = 580.71 Ns ± 32.60 Ns), however, no significant difference were found, $p > 0.05$. The velocity produced with right leg was significantly faster (m = 44.04 m/s ± 9.74 m/s) compared to velocity produced with left leg (m = 74.68 m/s ± 13.53 m/s), $p < 0.05$).

Discussions

This study was conducted to determine the muscle activity, kinematics and kinetics of lower limb during right and left leg forward lunges movement. Results showed during RL, no significant differences exist between all the muscles tested, $p > 0.05$ on the leading leg while EMG activity of biceps femoris was significantly greater compared to gluteus maximus, $p < 0.01$ on the non-leading leg.

An interesting point was the finding showed the gastrocnemius was the dominant muscle activated in the leading leg during lunges. Although the finding was in line with Feger, Donovan, Hart, and Hertel (2014), this was in contrast to the information that suggested lunge was the exercises for quadriceps as the dominant muscles. Quadriceps was found to be the dominant muscles during lunges as shown in previous studies (Fauth, Garceau, Wurm, & Ebben, 2010; Harput, Soylu, Ertan, Ergun, & Mattacola, 2013; Longpré, Acker, & Maly, 2014). The differences of muscle activation could be attributed to the fast movement that been performed where participants might pushed their legs using gastrocnemius in the concentric action. The differences in procedure used (e.g. tempo) might have changed the activation of muscles in the same movement. However, no significant differences were found between all the muscles in the leading leg during RL. Results also showed that biceps femoris become the dominant muscle to be recruited in the non-dominant leg during RL. The activation of biceps femoris were shown to be significantly higher compared to gluteus maximus.

During LL, EMG activity of biceps femoris was significantly greater compared to gluteus maximus, $p < 0.05$ on the dominant leg while EMG activity of rectus femoris was significantly greater compared to gluteus maximus, $p < 0.01$ and gastrocnemius, $p < 0.05$ on the non-leading leg. Results showed that biceps femoris was the dominant muscle to be recruited in both leading and non-leading leg during LL followed by gastrocnemius, rectus femoris and gluteus maximus. Thus, this showed that for both lunges movement, the activation of gastrocnemius was higher compared to rectus femoris. However, no significant differences were found. This finding again suggested the existence of changing movement tempo effects on muscle activation.

Further analysis was conducted comparing the muscle activation of leading and non-leading leg during both lunges. For the leading leg, results showed the EMG activity of rectus femoris ($p < 0.01$) and gluteus maximus ($p < 0.05$) of the right leg during RL were significantly higher compared to left leg during LL. For non-leading leg, results showed the EMG activity of rectus femoris of the left leg during RL were significantly higher compared to right leg during LL, $p < 0.05$. the differences of muscle activation could be a possible indication of strength level of the muscle in which if the muscle was not strong enough to do the movement, activation of other muscles were needed to balance the movement. The differences of muscle activation could also be attributed to the differences in form during movement.

Assessing the muscle activity, the current study showed biceps femoris to be the most dominant muscle during lunges followed by gastrocnemius, rectus femoris and gluteus maximus. This finding contrasted several previous findings that found quadriceps muscles to be more activated compared to hamstrings (Fauth et al., 2010; Harput et al., 2013; Longpré et al., 2014). Fauth et al. (2010) found rectus femoris to be more activated than medial and lateral hamstrings among 16 women who participated in either NCAA Division I or club or intramural sports and lower body resistance training. Harput et al. (2013) found quadriceps muscles (vastus medialis and vastus lateralis) were more activated compared to biceps femoris among 20 healthy subjects (10 females and 10 males). In another study, Longpré et al. (2014) conducted a study on muscle activation after being fatigue of squat found that rectus femoris were more activated compared to biceps femoris.

Results showed the impulse produced by right leg (M=563.95 ± 22.45) was slightly greater compared to impulse produced by left leg (M = 580.71 ± 32.60), however, no significant difference were found, $p > 0.05$. Study on the relationship between impulses produced with sports performance was not well established. However, based on the basic information, impulse is the product of force and time (Hall, 1995). The increment in one or both variables will cause impulse to increase and vice versa. The slightly higher impulse produced by the left leg during LL could be attributed to the higher ground reaction force it produced. Hong, Wang, Lam, and Cheung (2014) in their study found the ground reaction force produced by the left leg was higher compared to right leg. Unfortunately, the current study did not examine the ground reaction force by both right and left leg. It is recommended for the upcoming researches to be conducted on investigating how impulses could benefit a high and quick speed sport performance. However, it should be noted that higher impulses could be beneficial for the legs as it could reflect the strength the leg has to produce that impulses. In badminton, the players need to perform repetitive sudden stop-and-go maneuvers that imposed players to high chances of injury especially by rapid and repetitive lunge steps that involve strenuous impact during heel contact (Robinson & O'Donoghue, 2008). The strength of the leg could play a big role to enables players to move into the best position to execute shots while maintaining good balance and body control.

The velocity produced with right leg was significantly faster (M = 44.04 ± 9.74) compared to velocity produced with left leg (M = 74.68 ± 13.53), $p < 0.05$. The differences showed the effectiveness of the dominant leg in producing faster movement compared to non-dominant. This was not good as slower movement in the non-dominant leg could results in inability to move back into position as the competitor will attack more to the non-dominant leg as if the opponent knew about the weakness. The slower movement performed by the left leg could be the cause of lower muscle activity in the left leg.

Practical Applications

Speed or velocity of in-court movement for badminton players is best described by their lunge ability (moving from point A to point B as fast as possible). Assessing lunges capabilities can best described in-court speed of movement. Strength and speed training programs for badminton players should incorporate lunge movements focusing on speed and agility, rather than sprinting across certain short distance. It is suggested that for more accurate assessment, badminton players should use lunge movement accompanied by muscle activation assessment and kinetics output measurement, in order to help determine the asymmetry and specific muscles ability apart from in-court agility.

Acknowledgements

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