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Kinematics Analysis of Dominant and Non-Dominant Lower Limb during Knee Strike among MuayThai Beginners

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Abstract. This study was conducted to determine and compare the kinematics of knee strike in MuayThai between dominant and non-dominant lower limb. Ten MuayThai beginners (mean age = 20 ± 1 years old) with less than one week experiences in MuayThai training were recruited and were asked to perform three trials of knee strikes for each leg (dominant and non-dominant). Joint angles and angular velocity of the movement were assessed for each trial. Repeated measure multivariate analyses of variances (MANOVA) were performed to compare the kinematics data between the dominant and non-dominant lower limb. Results showed no significant differences existed in all the joint kinematics examined between dominant and non-dominant lower limb. As the conclusion, MuayThai beginners demonstrated no differences of joint kinematics during knee strike between dominant and non-dominant lower limb.

1. Introduction

Thai Boxing or more popular known as MuayThai is a martial art and a method of self-defence. Started in the ancient times as a way to protect self from the enemies and even the animals [1], MuayThai now has become one of the most popular martial art sport in the world. A MuayThai match consisted of five rounds of fighting with three minutes per round and two minutes rest between rounds. Four offensive maneuvers are allowed to be used in MuayThai matches; punches, knee-strikes, elbow-strokes, and various kinds of kicks. All of these maneuvers can all be used to attack any part of the opponent's body.

Published studies in MuayThai has focusing on the injury analysis [2-5], physiological responses [6, 7], strength and conditioning [8], biomechanics [1, 9-11], performance analysis [12, 13] and psychology [14, 15]. A review by Mohamad [16] addressed the needs of more studies conducted on MuayThai for sports scientist and practitioners alike to develop systematic training and monitoring plan for MuayThai athletes.

In order to improve performance in a sport, it is important to analyse the movement especially the techniques that been allowed to be performed in a sport. One of the most important techniques

performed in MuayThai is knee strike. The knee strike is a strike with the knee, either with the kneecap or the surrounding area. There are three types of knee strike; i) straight, ii) curved and iii) flying. Of all these, the straight knee strike is the most popular and always been performed in a match. In this study, the straight knee strike will be used interchangeably with knee strike. The knee strike involves the thrusting of the front knee into the head or body of an opponent. Knee strike always been performed when the performer is clinching the head or shoulder of the opponent. An athlete that able to perform the knee strike effectively will have the ability to defeat their opponent by landing accurate shots to opponents' body part such as the head, stomach, ribs, thighs, solar plexus and hips.

Instead of the importance of the knee strike, lack of studies has been conducted on the action. Studies on the biomechanics of MuayThai has been conducted on analysing the kinetic and kinematic parameters of the roundhouse kick [1], and the kinematics of the two Thai Boxing clinching positions [10]. Trial and Wu [10] in their study analyse the lower limb kinematic during knee strike in two clinching techniques; i) double collar tie and ii) double underhook. The findings of the study stressed the importance of hip and knee joint movements in both clinching positions.

It is important for the research to be conducted specific to the movement involved in a sport as the findings will demonstrate the mechanical demands during the techniques execution that will then add the information and knowledge for training program design. Besides that, it is also important for study to be conducted on both the dominant and non-dominant limb as this will demonstrate any asymmetry that existed [17-19]. This study was conducted among the Muay Thai beginners to look at if there are any differences in terms of kinematics data among the population so that correction can be done by the coach and individuals in order to enhance the functionality of both limb sites. Previous studies conducted on comparing dominant and non-dominant lower limb kinematics in martial art has been conducted on the roundhouse kick in taekwando [20-22], turning kick in taekwando [23], front kick in karate [24], and clinching in MuayThai [9]. Lack of studies has been conducted on the knee strike kinematics differences between both limb sites.

Thus, it is the objective of this study to determine and compare the joint kinematics of knee strike in MuayThai. The analysis will involve both dominant and non-dominant lower limb and comparison will be made between both sides of lower limb.

2. Methodology

2.1. Participants

10 male MuayThai beginners (mean age = 20 ± 1 years old) were recruited as study participants. Participants have less than 1 week experience in systematic MuayThai training. Participants had no medical problems and were screened prior to testing using PAR Q. Each participant had read and signed an informed consent for testing approved by the Universiti Pendidikan Sultan Idris and Thaksin University Ethics Committee.

2.2. Knee Strike

Participants were involved in a familiarization session to familiarize them with the techniques execution. All information about the data collection procedure was informed during the familiarization session. During the testing session, participants were first allowed of 10-15 minutes warm up session that consisted of stretching and kicking practiced conducted by a qualified national level MuayThai coach. After warm up, participants underwent their knee strike assessment. Participants were instructed to take two steps behind before execute the knee strike movement. During the starting (ready) position, participants were asked to face an instructor that were holding a kicking target, with knees that were slightly bend, and the knee that was going to kick at that trial need to be in front of the other (Figure 1a). The participant raised his hand up to the front as to simulate in the real conditions (hands holding the shoulder or head of the opponent) (Figure 1b). The participant next do a step forward (Figure 1c) before execute a knee strike to the kicking target (Figure 1d). Participants were

reminded to perform the movement as hard and as fast as possible. Each participant was required to perform three trials for each leg that made up of total 6 trials for each participant.

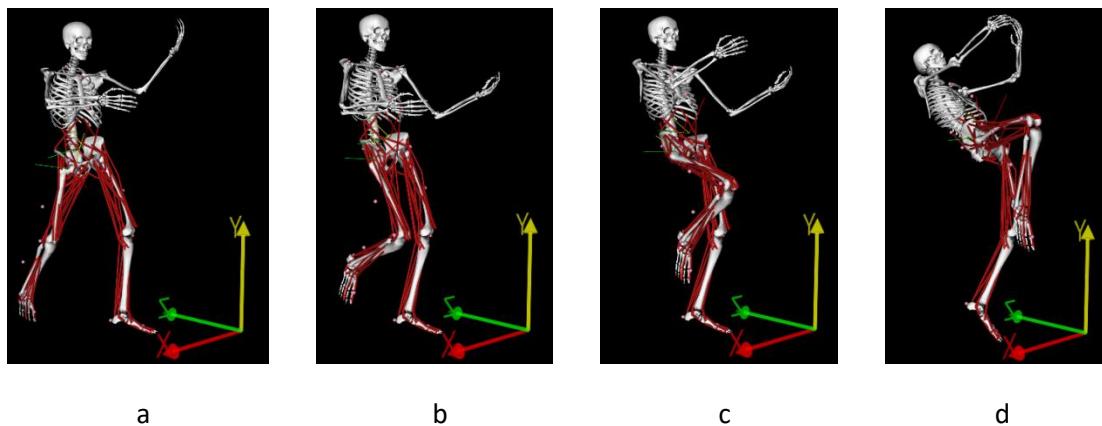


Figure 1

2.3. Kinematics Assessment

Six infra-red cameras motion analysis system (Vicon T10s, Oxford Metrics, UK) was used to collect kinematics data, sampled at 100 Hz. Based on the Plug-in-Gate Marker Set, 29 reflective markers were attached to participant body at the second metatarsal, lateral malleolus, calcaneus, lateral shank, lateral femoral epicondyle, lateral thigh and anterior superior iliac spine at both sides of body. The kicking target used was two hand-held kicking pads (MUAY THAI MT-KPC 1, Thailand). The kicking target was held by an assistant with hands at the body level of the subject. Analysis of data was conducted using Vicon Workstation software. The kinematic model of the lower body consisted of the shank, thigh and pelvis of the kicking leg. The angles of the hip, knee and ankle were examined.

2.4. Statistical Analysis

Descriptive data and mean score were measured using descriptive analysis. Repeated measure analysis of variances (MANOVA) was used to compare the differences of kinematics data between both dominant and non-dominant limbs. α -level of $p < 0.05$ was accepted as the statistical significance. All statistical analyses were conducted using SPSS version 23 (IBM, New York, USA).

3. Results

Table 1 showed the physical characteristics of participants involved in this study.

Table 1: Physical characteristics of participants

Age (years)	Body mass (kg)	Height (cm)	Right Leg length (cm)	Left leg length (cm)
20 ± 1	65.33 ± 2.68	170 ± 5	85.65 ± 4.63	85.50 ± 4.48

Table 2 showed the mean angle of dominant and non-dominant knee during the contact. No significant main effect were found for the knee flexion/extension, $F(1,9) = 0.332$; $p > 0.05$, knee internal/external rotation, $F(1,9) = 0.870$; $p > 0.05$, knee abduction/adduction, $F(1,9) = 0.863$; $p > 0.05$.

Table 2: Knee joint angles at contact

Knee	Dominant (mean ± SD)	Non-dominant (mean ± SD)	p-value
Flexion/extension (°)	112.40 ± 10.35	108.94 ± 10.72	.578
Internal/external rotation (°)	23.48 ± 13.84	28.32 ± 17.62	.375
Abduction/adduction (°)	7.78 ± 15.81	2.18 ± 10.11	.377

Table 3 showed the mean angle of dominant and non-dominant hip during the contact. No significant main effect were found for the hip flexion/extension, $F(1,9) = 1.239$; $p > 0.05$, hip internal/external rotation, $F(1,9) = 0.824$; $p > 0.05$, hip abduction/adduction, $F(1,9) = 1.368$; $p > 0.05$.

Table 3: Hip joint angles at contact

Hip	Dominant (mean ± SD)	Non-dominant (mean ± SD)	p-value
Flexion/extension (°)	35.63 ± 18.39	42.68 ± 16.61	.295
Internal/external rotation (°)	-33.90 ± 16.34	-28.81 ± 11.52	.388
Abduction/adduction (°)	5.19 ± 20.98	13.09 ± 14.79	.272

Table 4 showed the mean angular velocity of knee and hip flexion for both dominant and non-dominant sites. No significant main effect were found for the knee flexion velocity, $F(1,9) = 0.019$; $p > 0.05$, hip flexion velocity, $F(1,9) = 0.714$; $p > 0.05$.

Table 4: Angular velocity at contact

	Dominant (mean ± SD)	Non-dominant (mean ± SD)	p-value
Knee flexion (°/s)	133.41 ± 62.22	143.46 ± 56.84	.893
Hip flexion (°/s)	258.89 ± 214.47	203.34 ± 55.42	.420

Table 5 showed the mean of knee forward and knee vertical linear velocity for both dominant and non-dominant sites. No significant main effect were found for the knee forward velocity, $F(1,9) = 0.211$; $p > 0.05$, knee vertical velocity, $F(1,9) = 0.508$; $p > 0.05$.

Table 5: Peak linear velocity

	Dominant (mean ± SD)	Non-dominant (mean ± SD)	p-value
Knee forward (m/s)	1.04 ± 0.90	1.15 ± 0.52	.657
Knee vertical (m/s)	4.15 ± 1.30	4.38 ± 1.43	.494

4. Discussions

Knee strike is one of major offensive techniques performed in MuayThai and it would be interesting to explore further on its techniques execution and effect. This study was conducted to determine and compare the joint angular displacement, velocity and acceleration of the hip, knee and ankle during knee strike for both dominant and non-dominant lower limb.

First of all, this study had found that no significant differences existed for all the kinematics comparisons made between dominant and non-dominant lower limb. Similar findings can be seen in other previous studies that had compared dominant and non-dominant lower limb kinematics in martial art [9, 20, 22-25].

No significant differences were also found for the angles of joints examined in this study. At first, it was thought that since knee strike techniques can be said as exclusively applied by MuayThai fighters only, with different kicking techniques compared to other types of kicks, the outcome may be different. But it seems this findings was consistent with several previous findings that had also found no significant differences of lower limb joint angles during turning kick in taekwando [23], front kick

in karate [24], clinching in MuayThai [9] and roundhouse kick in taekwando [21, 22]. It is suggested that the similarities may be due to the nature of combat sports where regardless of dominant or non-dominant, both opponents need to be prepared and use both legs in defending and attacking movements.

Looking at the velocity data, no significant differences were found for all the angular and linear velocity examined in this study. This was partly in contrast to the findings of [9] that found joint angular velocity for the knee joint was faster for the dominant compared to the non-dominant leg during knee strike in two different clinching technique. Moreover, study by Hsieh, Huang [20] found that dominant leg is significantly better than non-dominant leg in the peak toe velocity, impact toe velocity and peak ankle linear velocity.

The explanation behind this contrast in findings could be caused by the differences of participants recruited in which this study involved beginners while Hsieh, Huang [20] and Trial [9] recruited highly experienced martial art practitioners. Different kinds of techniques execution could also contribute to the differences in which Hsieh et al. (2012) in their study conducted roundhouse kick in Taekwando which is a more complex movement compared to the knee strike in this current study. Knee strike could be said as a simple movement in which participant only need to raise the knee in front. Perhaps, the easiness of the technique has caused the participant to able to perform the knee strike with the non-dominant leg as efficient as the dominant leg.

When comparing the current data to the previous conducted by Trial [9], it can be seen that the velocity data obtained in this current study were far less than obtained in Trial [9]. The differences could be explained by the differences of participants recruited. Participants in this current study were beginners that just started MuayThai training for less than a week. The participants were believed to still have lack of motor abilities to perform the movement as efficient as the participants recruited by Trial [9] that were trained and have at least 5 years experienced in MuayThai training that are believed to already adapt and master the movement.

5. Conclusions

This study provides an important understanding on the kinematics of one of the most popular techniques performed in MuayThai, the knee strike in both the dominant and non-dominant lower limb. Ten MuayThai beginners were recruited and each athlete performed three trials for each sites. The findings of this study indicate no significant differences were found during knee strike between dominant and non-dominant lower limb. More biomechanics researches using advance technologies are warranted to be done on MuayThai technique as the speed of the martial art movements were very high make them virtually impossible to be analysed with the naked eye, and many traditional assumptions about optimal techniques may be incorrect.

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