# Kinematic Analysis of Sipa sa Mangis: Exploring the Science of the Art

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**Abstract**

The purpose of this study is to give a baseline information on the kinematic study of kicking, *Sipa sa Mangis,* and to determine what muscle activities are involved during that motion. Sipa sa Mangis is one of the traditional sports of Muslim people in Mindanao. Inside kick is the primary skill used in this sport. This study was conducted at Sports Biomechanics Laboratory Facility of Korea Institute of Sports Science, Seoul South Korea. To analyze the motion, Nineteen (19) High definition infrared motion cameras (Qualisys Oqus 701+19) were placed with the Ground Reaction Force Plate at the center of a captured volume of a 3m x 4m x 2m. (Kistler Type 9281B11). The coordination was calibrated using an L-frame and T-wand for 60 seconds at a sampling rate of 120 frames /sec. Each camera was synchronized using data cables while one master camera delivered the data to the main frame via a LAN cable. The data was analyzed and processed through Qualisys Track Manager. To determine the muscle activities while kicking, the surface Electromyography (EMG) fitted electrodes were placed at the 12 motor points of the leg muscles. All the three sets of data were analyzed using RMS and FIR frequency filters. The initial and termination portion of the signals were ignored for analysis to avoid any noise creeping in. The sampling rate is 1500Hz where RMS filter was calibrated at 50ms and FIR filters at 80-250Hz. Result of the study is revealed through EMG analysis; the Right Tibia Anterior and Right Gastrocnemius muscles were highly activated throughout the different phases of kicking motion.

*Keywords: kinematic analysis, Moro game, kicking*

The Philippines is an island country composed of 7,017 islands. These thousands of islands are grouped based on geographical location to form three big groups of islands known as Luzon, Visayas and Mindanao. Mindanao is the second largest group of islands which is located at the southern part of the country, and was once a Muslim dominated place. *Sipa sa Mangis* is one of the traditional sports of Muslim Filipinos in Mindanao. Long ago, only a member of the royal family could play the game. During my interview, an old Maranao *Imam* (teacher) narrated that the winners in the game could bring home a carabao, cow, goat, poultry, rice and land title as their prize for winning. The game symbolized fame, power, honor and pride. The Sultan *(tribe's highest monarch)* would give the hand of his daughter for marriage to the person who would win the game. Maranao, Maguindanao and Tausug are the three largest tribal groups among the 13 muslim tribes in the Philippines (*Agoncillo,1990*). Each tribe has a unique way of playing *Sipa sa Mangis*. The rule maintains its distinct characteristics to preserve and respect how their great- great ancestors played the game.

*Sipa sa Mangis* is the origin of some of the traditional games in the Philippines. The *Pabitin* and *Takyan,* among others, are very popular and common recreational games among children. *Sipa sa Mangis* also influenced the Philippine national sport, known as Sipa (*Sepak Takraw in Malaysia*).

It is a sad reality that the new generation of youth now does not know how to play this game or even hear about it. Lack of exposure and a chance to engage in this game in public and in schools are the major problems. Concerned about the deterioration of this rich Moro traditional game, some Muslim activity organizers in Mindanao lobbied for the inclusion of this game. Today, *Sipa sa Mangis*

forms part of festival celebrations and some significant Muslim occasions like the Eid'l Fitr and Eid'l Adha.

Kicking is the primary skill used in playing *Sipa sa Mangis*. The game begins with the inside kick, followed through with another kick and the game continues until a player fails to kick the ball back to his opponent. The delivery of the inside kick begins at the eversion of kicking foot, internal rotation of leg and continues into the follow through phase. The resultant power comes with the velocity of the kicking motion (Young, 2011). The greater the velocity of the kick, the greater the power of the foot has to hit the ball. During the point of contact, the height of the ball depends largely on the amount of force applied to kick the ball. Kick is modelled as a three-link kinetic chain composed of the segmental forces of the thigh, knee and foot (Vie, 2013). Understanding the concept of human movements particularly in the execution kick is very important because it leads to improvement of skill by correcting the wrong execution and suggesting the best and effective delivery (Lee, 2010).

The purpose of this research is to study the kinematic motion of kicking *Sipa sa Mangis* and to determine the muscle activities while performing the kick. The researcher believes that kinematic research about Sipa sa Mangis will give baseline information that can be used to improve sports techniques, prevent injuries and encourage future research and development of a program based on the outcome of the research conducted.

## Materials and Methods

This study was conducted at the Sports Biomechanics Laboratory Facility of Korea Institute of Sports Science, Seoul, South Korea from the period of August to November, 2015. The subject of this study was the researcher himself. He has been playing this game for 15 years.

**Video Analysis System**

To study the kicking motion, the Qualisys Oqus 701was used. Qualisys Oqus 701 is a high speed motion capture equipment with 19 infrared camera that were placed surrounding the ground reaction force plate with a captured volume of a 3m x 4m x 2m. (Figure 1). Prior to the data collection, the coordinate system was calibrated using an L-frame and T-wand for 60 seconds at a sampling rate of 120 frames /sec. Each camera was synchronized using data cables, while one master camera delivered the data to main frame via a LAN cable. The analysis of the data was performed through Qualisys Track Manager Software ®.

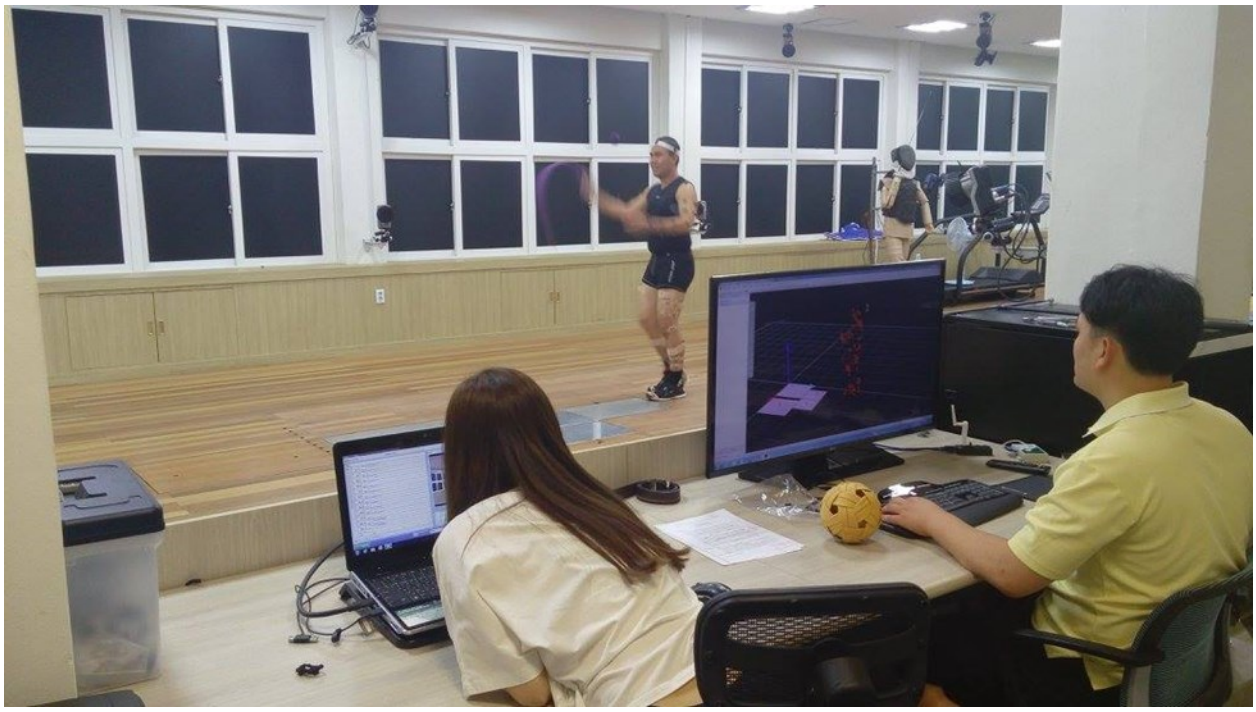

Figure 1. The subject (in sports attire) is in the center of Ground Reaction Force (GRF) Plate surrounded with High Speed Motion Capture Instruments.

**Electromyography (EMG)**

To determine the muscle activities during the kicking motion, the experiment was conducted using Biometrics EMG Acquisition System (Noraxon, USA). The surface EMG preamplifier fitted electrodes were placed at the motor points of the selected muscles as seen in Figure 2. All the three sets of data were analyzed using RMS and FIR frequency filters. The initial and termination portion of the signals were ignored for analysis to avoid any noise creeping in. The sampling rate is 1500Hz where RMS filter was calibrated at 50ms and FIR filters at 80-250Hz (Figure 3).


Figure 2. The subject being placed with EMG electrodes on the different parts of his body.

## Results and Discussion

**Phases of Event**

The kicking motion was divided into phases of event. This is a continuous process that differs in how the motion takes place (Krekel, 2010). The sequence of kicking motion was divided into: Event-1(*ready stance*); Event-2 (*tossing*); Event-3 *(snapping)*; Event-4 (*kicking*); Event-5 (*recovery*); Event 6 (*finish)*. E1 began when the subject stepped on top of Ground Reaction Force Plate (GRF). E2 startted when the left arm was raised to toss the ball, E3 commenced when the right arm snapped the *musala* (handerchief), E4 began when the right foot kicked the *balagen na bola* (ball), E5 when the right foot started to lower down and E6 when the subject returned back to the ready position (Figures 4 and 5).

**Ground Reaction Force**

According to Newton's 3rd Law of Motion

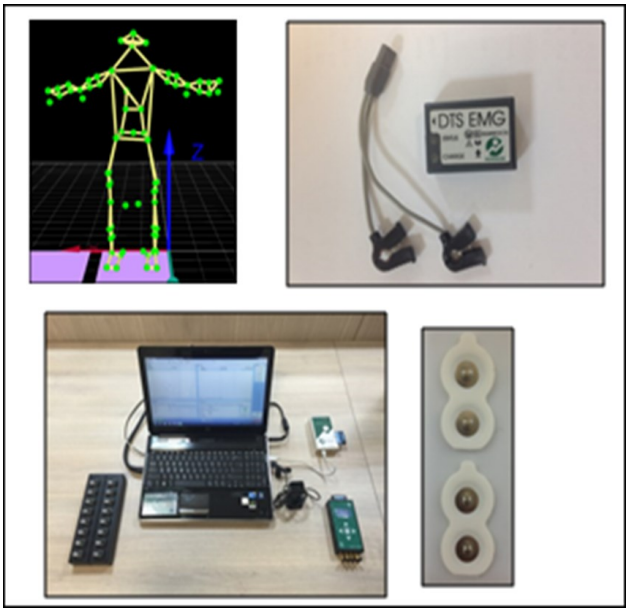


Figure 3. The instruments used to calibrate a sampling rate of 1500 Hz.

(Law of Reaction) in every action, there is an equal and opposite reaction (Li, 2012). In this study, the amount of force the subject exerted against the ground was measured through the Ground Reaction Force Plate. The graph shows that the maximum amount of force exerted was seen between E3 (*snapping)* to E4 *(kicking)*.

To determine the muscle activities during the course of motion, different surface EMG electrodes were placed above the skin. These surface electrodes assessed muscle function by recording muscles activities. EMG eletrodes were placed on both right and left of rectus femuris, tibia anterior, biceps femuris, semitendinosus, lateral gastrocnemius and medial gastrocnemius muscles (Figure 6). EMG graph result reveals that there is less activity

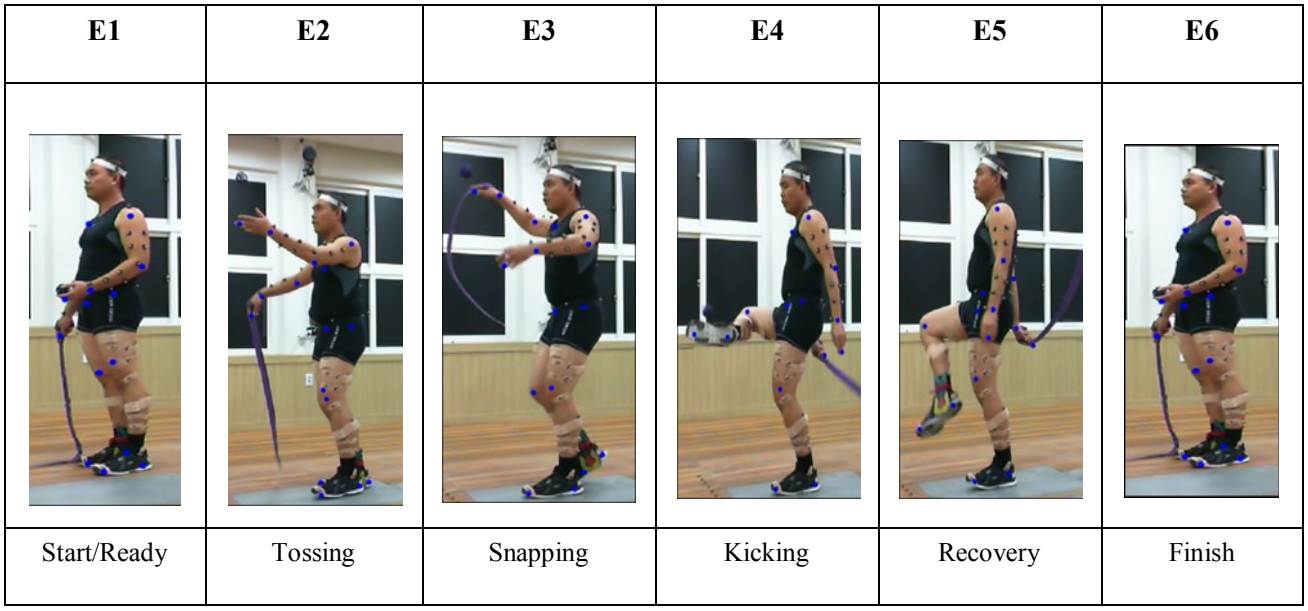


Figure 4. The kicking motion in the different phases of events.

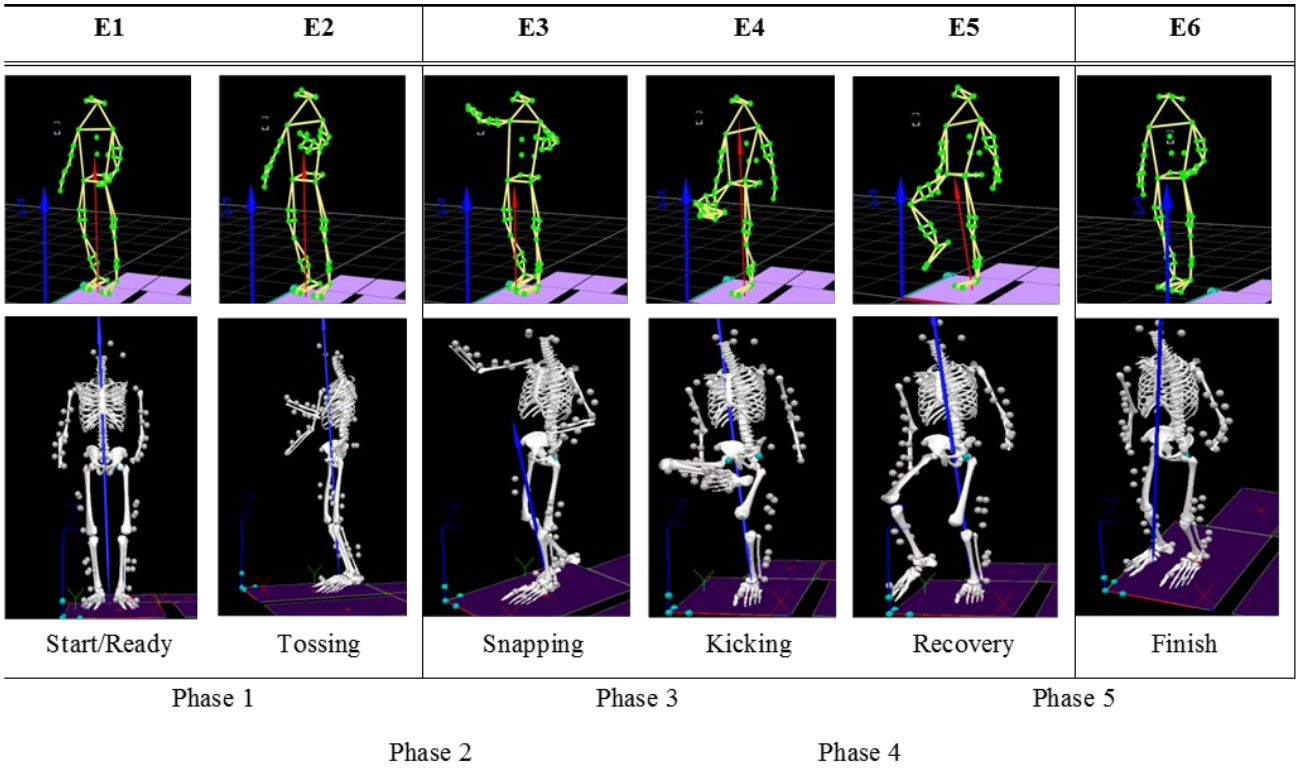


Figure 5. The 3D animation and skeletal figures of the subject in the different phases of the kicking motion.

in the left lateral gastrocnemius muscle throughout the kicking motion. This can be true because the primary function of this left leg muscle in the stationary inside kick is to give balance and maintain equilibrium while the right leg is doing the kicking motion. There is no walking or running approach involved in this activity. It can be noted also that the left tibia anterior was activated from E-2 (*Tossing)* to E-5(*Recovery*) in order to absorb the amount of force and the body mass. The right tibia anterior muscle is responsible for dorsiflexion and inversion of the foot which triggered the inside kick. Moreover, the study shows that the tibia anterior as well as gastrocnemius muscles were highly activated compared to other group of muscles.

**Presentation of Muscle Activities Throughout Kicking Motion**

Figure 7 is a snap taken from the video analysis to show the synchronization between the performance of kick and muscle activities. The waves of the graph represent muscle activation. Straight line means the muscle is dormant. Waves means the muscles are used. The higher the wave, the more activated the muscles are. There were 12 leg muscles that were studied. EMG electrodes

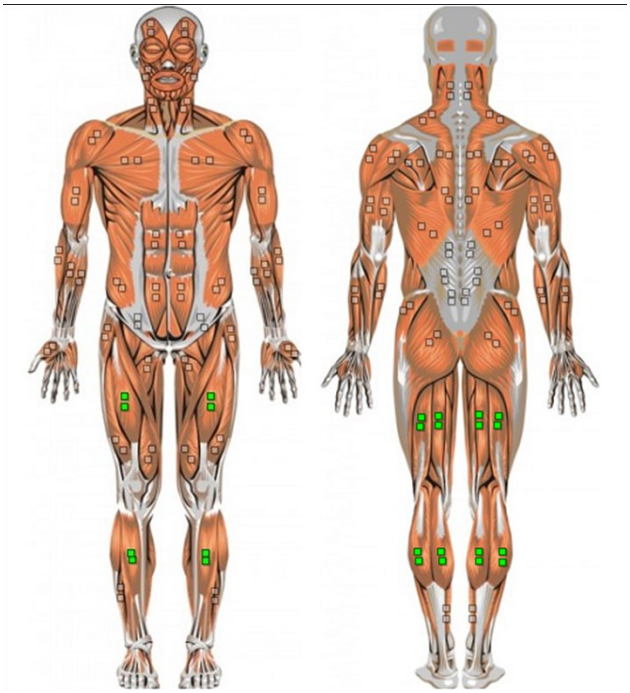

Figure 6. The leg muscles being studied as represented with green marks.

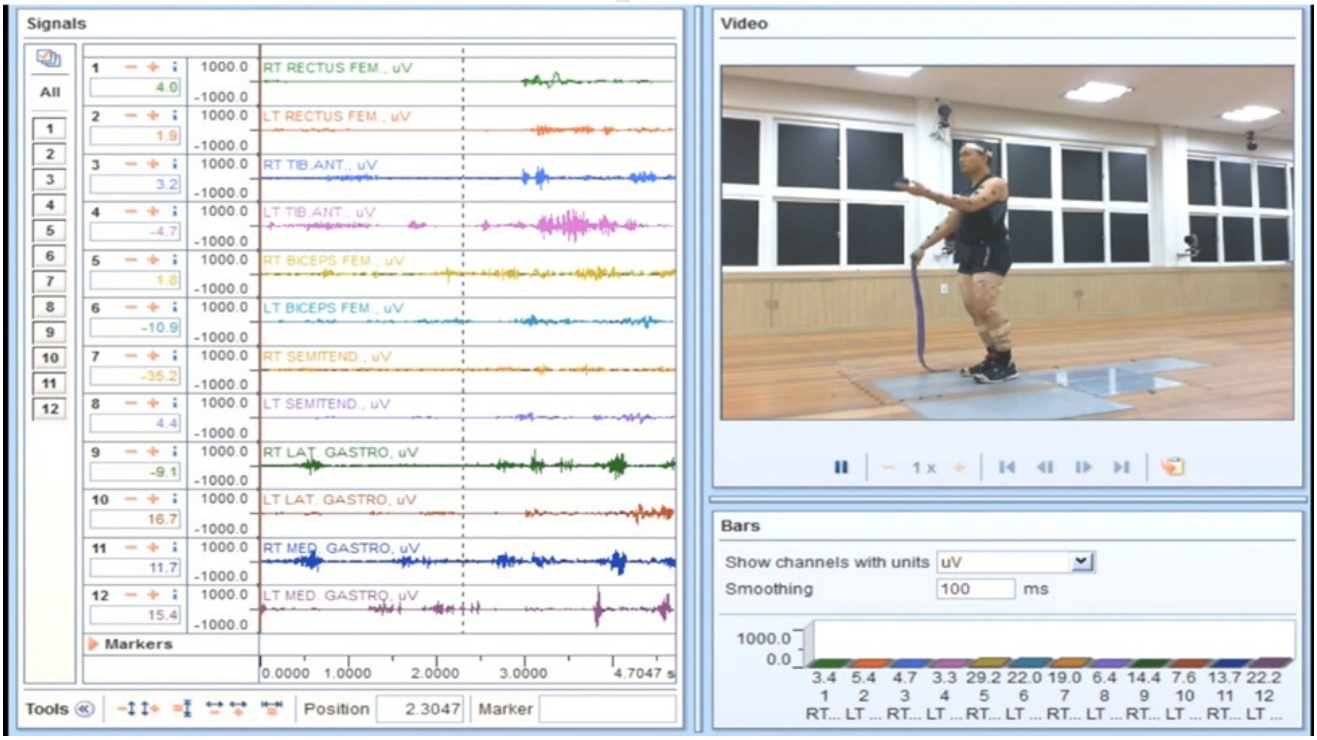


Figure 7. A snapshot from the video analysis showing the synchronization of movements and muscle activities. The EMG graph to the left shows the activity of the muscles while the subject is performing the action (right).

were placed at the different motor terminal to capture and analyze the activity (Sekir,2013). Based on the result of the EMG graph, the (L)& (R) Gastrocnemius as well as the (L) Tibia Anterior were muscles that were always used and highly activated.

## Conclusion

This is the first time that the Sipa sa Mangis was studied scientifically. The researcher achieved the objective in establishing baseline information in order to encourage possible research in the improvement of skills and other areas of performance in the future.

Specific exercise must be given to Tibia Anterior as well as Gastrocnemius muscles in order to increase the angular velocity of the kick. Increasing the angular velocity will toss the ball up. These two groups of muscles were mostly activated during the kicking motion.

The ankle inversion during the contact must be analyzed in order to determine the consistency of flight and trajectory of the ball. Timing and consistency are very important in hitting the *Mangis* (suspended basket) with accuracy. Thus, further research will be established to analyze this area.

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