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Biokinematical Analysis for "Mai - Mawashi - Geri" Based on Two Different Levels of the Competitor's Body in Karate

Ahmed Mahmoud Said El-Daly

Department of Kinesiology, Faculty of Physical Education, Helwan University, Egypt

Abstract: This research aims to make a biokinematical analysis for Mai-Mawashi-Geri skill from a static position in two different levels of the competitor's body (the abdomen area and the face area). This is done by using the motion analysis and the electromyography measurements of the lower limb which constitute some of the essential muscles that perform the skill. In doing so, the relationship that occurs during the analysis and the measurements is discovered. One player from the Egyptian national team was chosen as a sample for the study. It was essential to use the motion analysis and its relationship to the electromyography in order to understand all the movements and thus arrive to the optimal performance.

Key words: Biokinematical analysis % Electromyography measurements % Mai - Mawashi - Geri

INTRODUCTION

The motor performance can not be implemented in a distinct manner unless it is subjected to search in several ways, including biomechanics, which studies the performance as a dynamic system of complex motor acts based on the use of potential and motor skills ideally used by a player, in order to achieve optimal performance. Biomechanics can also contribute to improving the training requirements through the identification of the physical performance and skill required to perform a particular sport and can also contribute to the improvement of technical training in many ways through conducting a qualitative and quantitative biokinematical analysis of the real performance. It could also contribute to improve the technical performance training by identifying the exercises which are similar to a large extent to the type of practitioner performance techniques [1, 2].

Also motor performance has been a reflective issue of a wide range of complex biological processes. Each group of researchers is interested in one process. However, it can be considered that the mechanical movement associated with the performance is the last episode of this reflective issue which can be understood and quantified easily. Careful consideration of the principles and the foundations by the workers in the field of motor performance will reveal that there are two major dimensions which should be investigated well: the first dimension considers the interpreted mechanical principles and foundations of skillful performance. The second dimension has to do with the structural and functional principles and foundations. Both dimensions are associated with building the human body and its movements but the use of each differs from the other [3, 4].

It has become necessary for the trainer to have information about the characteristics of the skill performance in order to facilitate the training process. This can be achieved by revealing the interrelationships between the different movements of body parts during the performance of the skill which cannot be obtained unless by observing and analyzing the player's movement through performing the skill. It was confirmed that performance characteristics require that the researchers collect all information related to the work of the body parts (the joints and muscles), especially if the objective of the study is to reveal information for both the practitioner and the novice about correcting performance to achieve the optimum performance [5, 6].

The Karate kicking skills are one of the main pillars of the karate structure. Although several aggressive tactics in kumises, these methods use legs - whether in the form of movements or kicks - it occupies a central place in leveraging the players during the games [7, 8].

Since winning in kumite matches requires many factors like proficiency in many of the kicks, punches and defenses. The skillful and tactical performance will not be implemented if strong and effective kicks are ignored, as the kick skill groups play an important and essential role in the attack due to its recruitment of large muscle groups,

Corresponding Author: Ahmed Mahmoud Said El-Daly, Department of Kinesiology, Faculty of Physical Education, Helwan University, Egypt

which are inherent in the legs which produce a suitable amount of muscle efficiency that can be used in the skillful and tactical performance of the attack [7, 9, 10].

Mai-Mawashi-Geri skill is considered one of the important and effective kicking skills in kumite matches as it is considered a combination between the two basic technical skills of karate: Mai-Geri front kick and the Mawashi-Geri circular kick [11]. The difficulty of this skill is represented in the overlap of the technical performance of the core skills mentioned above. In addition, the skill can be performed on two different levels of the body as allowed by international law, where the game gives the player a penalty leading to two points in the registration status of kick in the abdomen or chest (Trunk) and three points in the case that the kick records in the face [12].

This has prompted us to try to study the technical design of the performance of the skill "Mai-Mawashi-Geri" based on a stability position and the front leg in two different levels of the competitor body (Trunk) and (Face) by code-analysis to identify the dynamic characteristics, as well as to study the amounts of electrical activity of the lower limb core muscles involved in performance.

Aims:

- Defining the dynamics of the lower part related to the investigated skill.
- Defining the major working muscles during performing the investigated skill and their contribution rates.
- Defining the mutual relationship between the amounts of the electrical activity (EMG) of the working muscles and the biokinemechanic parameters of the investigated skill on two different levels.

Hypothesis:

- What is the geometric path of the body's center of gravity for the investigated skill on the two levels of performance?
- What are the main working muscles during the performing of the investigated skill and their participation rate in the performance?
- What is the relationship between the angular change of the striking leg joints and the electrical activity of the working muscles?

MATERIALS AND METHODS

The researcher used the descriptive method using a device to measure the electrical activity of muscles (EMG) and Biokinematical analysis using video-graph and motion analysis.

Sample: Includes one player selected intentionally from the Egyptian national team.

Procedures

Electromyography (EMG): The researcher conducted an exploratory experiment to determine the working muscles during performing the investigated skill and to identify the most active muscle to conduct the test and make sure that the transmitter and receiver units and frequency control capacity of the electrical signals derived from the device measure the electrical activity of muscles while working and ensuring the integrity of the recording channels during measure the activity of eight muscles (Rectus Femoris - Vastus Lateralis - Vastus Medialis R, L - Semitendinosus R, L - Multifidus - Tensor Fasciaelatae in conjunction with the process of video graphic [13].

Video Graphic and Biokinematical Analysis: The researcher conducted an exploratory experiment for the video-process which was designed to:

- Ensure the right positioning of cameras.
- Set digital cameras for video graphic.
- Using light reflexive labels on the joints.
- System calibration was designed related to the investigated skill.
- The player made a number of trials on two levels of kicking to choose the best trial at every level to conduct the biokinematical analysis.

Research Parameters

- The kinetic path of the body's center of gravity for the investigated skill on the two levels of performance.
- Angular change of the striking leg joints at various stages of performance.
- Participation rate of muscles in performance (Work – Loading).

RESULTS AND DISCUSSION

Discussion of the Geometric Path of the Body's Center of Gravity: Fig. 1 shows the geometric path of the body's center of gravity for the investigated skill during the various stages of performance on different levels. It reveals a decline in values that represent the preliminary phase of the level of performance on the face than in

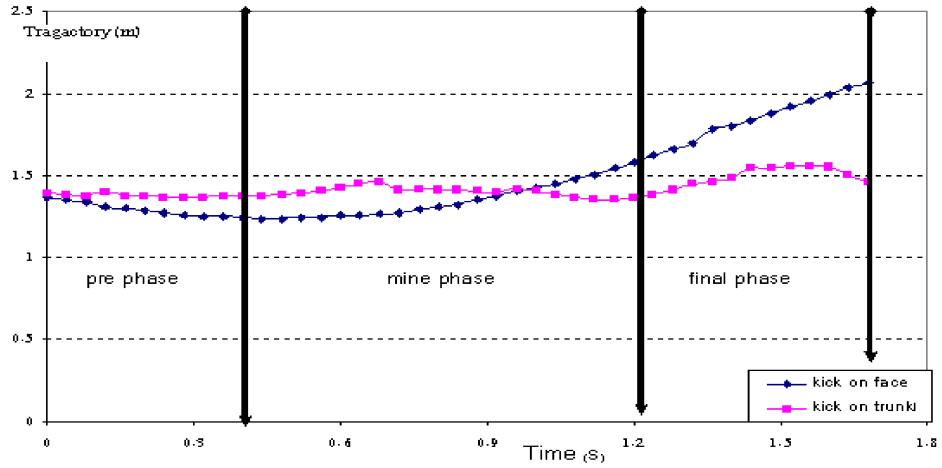

Fig. 1: The geometric path of the body's center of gravity for the investigated skill at two levels of performance

the same performance stage on the trunk; that explains the performance of the skill on the face down to the bottom of the body and forth to give the body acceleration and reaction capacity of the muscle in the opposite direction to the process of flux "soft landing" that characterizes the initial phase; which is the exact opposite of what happens at the same stage of kicking on the trunk because the performance of the kick on the trunk does not require the preparation of technical relegation to the lower part of the body.

The researcher believes that this stage is one of the most important stages of the performance technically at both levels of performance as it is the stage that defines the direction and level of kicking as well as to be regarded as a prelude to twin skills "Mai-Geri and Mawashi-Geri" together formulating the investigated skill. Therefore, success in this stage results in the success of the skill as a whole. A study of the main stage performance on the face reveals the continuing process of preparing the landing to produce a kind of deception which may cause a gap in the defenses of the rival player. The most important factors for the success of this stage are the mastery of camouflage and the anticipation of success due to the player's reaction to confront the attack. We note at the end of the rise in the basic shape of the geometric path of the body's center of gravity as a result of using the kinetic transfer characteristic of the lower body joints for directing the striking leg to the facial area.

A study of the basic period of performance on the trunk reveals the continuation of the increase of the body's center of gravity. The researcher thinks that this is due to the integration of the preparatory process of "camouflage" in the primary stage which should be faster and requires a shorter time of performance than on the face. Also the technical necessity, forces the player to complete his primary stage quickly due to the nearness of the player's rival. This stage is one of the longest relay in both levels of performance.

By studying the final stage of performance on the face, it was found that owing to the rise and farness of the aim, it requires availability of accuracy in guiding the kick to spare the rival any injury. And due to the availability of accuracy in performance, we find that the rise in the shape of the kinetic path of the body's center of gravity at this stage is essential to end the skill after dragging the kicking leg back and returning to the starting position again, "primary mode". This is a technical necessity to complete the process and follow-up the attack or confront a counter-attack by being ready to defend the body in a standing balanced position. But on the trunk, we also find an increase in the shape of the kinetic path of the body's center of gravity as this stage is characterized by force to end the kick followed by rapid reversal of the situation in the primary for the performance of skill in preparation for the attack again and because of the proximity of the aim and directed to width of the kicking area "trunk"; the accuracy factor decreases and the technical necessity requires that the player had to recoil back and land the kicking leg. Due to the high technical level of the study sample and this was confirmed by the clear flowing curves that characterize the form of crossings of the geometric path of the body's center of gravity in both performance levels.

Discussion of the Participation Rate of Working Muscles During Performing the Investigated Skill: By tracking the results of the participation rates of the working muscles involved in performing the investigated

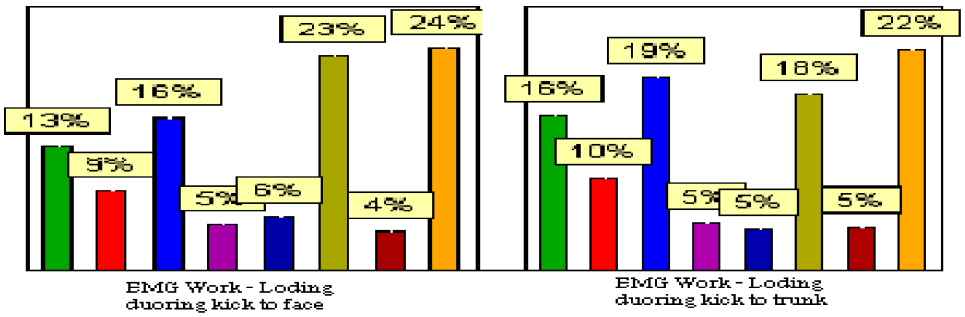

Fig. 2: The participation rates of working muscles during the performance of the investigated skill at two different levels

skill. As shown in Fig. 2, it was found that there is a significant disparity in participation rates of muscle force, where they participate in the more muscular performance-oriented to the face "Quadriceps – middle fibers" of the fixed leg with a rate of 24% of total performance, followed by "muscle multidisciplinary" with a rate of 23% of the overall performance recorded "Quadriceps - middle fibers" of the kicking leg participation rate of 16%, the participation rate of "Rectus Femurs" of the kicking leg was 13%. While the participation rate for "Quadriceps - inner fibers" of the kicking leg was 9%. However, the participation rates of the rest of the muscles "Semitendinosus L" of the kicking leg, "Quadriceps - outer fibers" and "Semitendinosus R" of the fixed leg was recorded to have the lower participation rates of 6%, 5%, 4%, respectively.

Therefore, the previous review of the participation rates of the muscles involved in the performance of skill on the face, the researcher found that the most participating muscles is the "Quadriceps - middle fibers" of the fixed leg which illustrates the importance of the fixed leg for the success of the performance of the skill. The role of the muscle at different locations and functions of not only the violent contractions, but some of these muscles play a greater role in the installation as well. This is illustrated by the large turnout for this muscle which was adopted on the performance of this muscle during the process of camouflage and deception that characterized the Preliminary phase. Also we can not forget the role played by the rest of the muscles to actively participate in the installation and contraction process to complete the kicking process successfully with balance and accuracy, clarifying that such complex motor skills require a great deal of fixed muscle strength.

Through examining the results of muscle electrical activity and participation rates in the performance of skill on the trunk, the study found that the most participating muscle in the performance is the "Quadriceps - middle fibers" of the fixed leg with a rate of 22%, followed by the "Quadriceps - middle fibers" of the kicking leg with a rate of 19%, this demonstrates the importance of the role of this muscle in performance. Then came the role of the "dorsal muscle" with a participation rate of 18%, then "Rectus Femurs" with a rate of 16% and then came the participation rate of "the Quadriceps - inner fibers" with a rate of 10%. The participation rates of the rest of the muscles were equal "Quadriceps - outer fibers", "Semitendinosus L, R" with the participation rates of 5% each.

By studying the differences between each kicking on the face and the trunk, it was found that the role played by the muscles involved in performance are similar to a large extent. And that the fixed muscles have a significant role in the success of the kicking process at both levels. Despite the small size of "Rectus Femurs", its role in the delivery of the kicking leg to the highest level is essential. There is also an active role of "dorsal muscle", as its percentage of participation in the performance is big, although its work depends on being fixed during the process of kicking.

From the above mentioned, it is clear that there are clear differences in the values of the electrical activity of the investigated muscle on the two levels of performance and these differences explain the importance of the effective role of the simultaneous analysis of the muscle work with the motor analysis of the sport skills.

Angular Change of the Striking Leg Joints and its Relation to the Electrical Muscle Activity "Participation Rates" of Performance on the Face

Preliminary Stage: The results of the angular change as shown in Fig. 3 reveals a large difference in the potential of every joint for movement and the anatomical function. At the beginning of the kicking preparations the foot angle was limited between 77° and 118°, which was the beginning of preparation and the stage of camouflage and deception of the kicking leg, this is where the player extends the strike of the leg in front of "Mai Geri" and

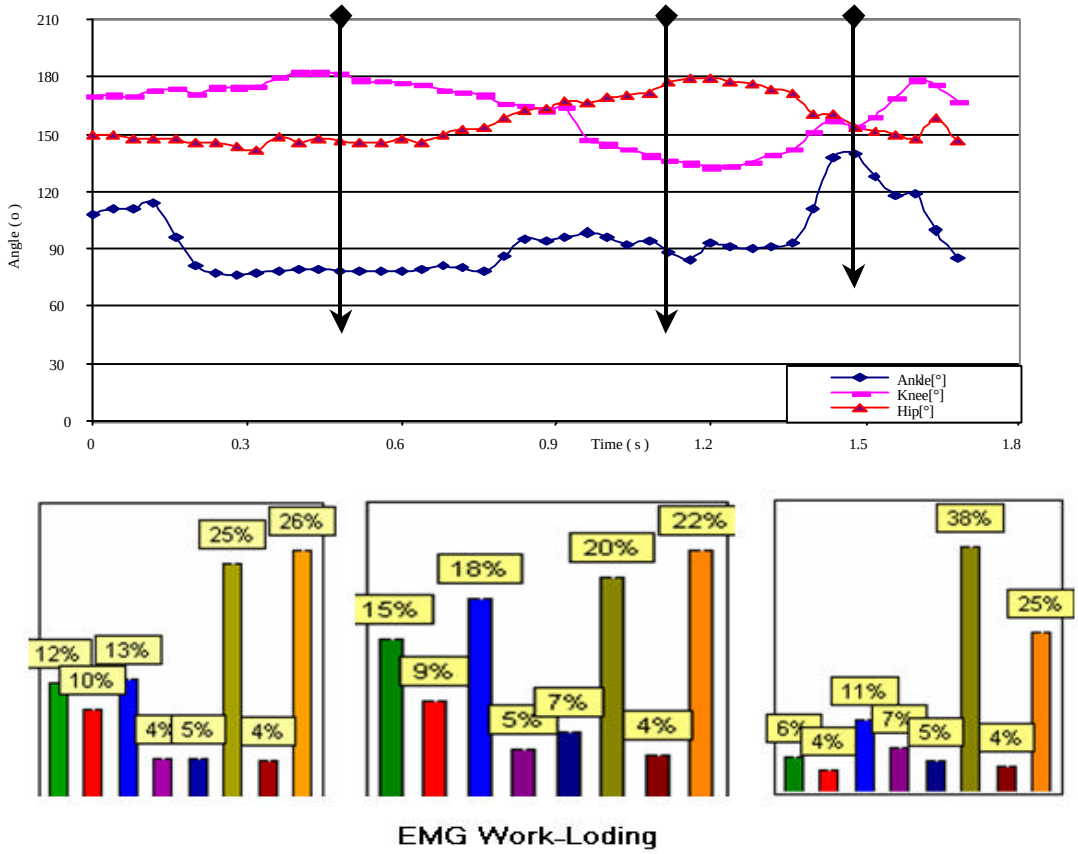

Fig. 3: Angular change for stick leg on face

once again pulled back to lift the knee high. The angle of the knee was limited between 168° and 180° during the phase of initial stretching for camouflage and deception, while the thigh angle was between 143° and 151°. As for the electrical activity of muscle at this stage, the role of each of the "Multifidus" and "Quadriceps - middle fibers" of the fixed leg were highlighted as their participation rates were 25%, 26% respectively, i.e. the primary dependence at this stage is on the fixed muscles until the process of deception is to the fullest.

Primary Stage: The foot angle continued to be fixed during the process of deception with the front foot with a value of 77° up and reached the highest value at the end of the main stage to 104°. Also the angle of the knee has decreased to reach the lowest values in the beginning of this phase during stretching the leg to the face, the kicking area between 171° and 180°. Thus, the kicking process is completed quickly to avoid a counter-attack and the angle of the thigh has been increasing remarkably limited between 146° and 178°. By the follow-up of the working muscles participation rates, we find that despite the increased activity of some muscles, such as "Quadriceps - middle fibers" of the kicking leg with a rate of 18% and "Rectus Femoris" with a rate of 15%. The role of the fixed muscles did not end yet, it continued to strengthen and support the rest of the working muscles to do its part in ending the process of kicking up to the values of 22% for "Quadriceps - middle fibers", 20% of " Multifidus".

Final Stage: The foot angle is limited between 85° and 138° to reach the end of this phase to be at 85° to where the kicking leg reaches the land. The angle of the knee show increased values after kicking and during the passage of the kicking leg during the landing process to record the values between 131° at the beginning of the final stage and 178° at the end of the stage when the foot become in contact with the ground after kicking. The thigh angle has continued to decrease to reach the least value of 143° at the end of this stage, given the participation rates of the working muscles has been confined to the highest values of participation among "Multifidus" with a rate of 38% and "Quadriceps - middle fibers" of the fixed leg at a value of 25% i.e. more than half of the total participation.

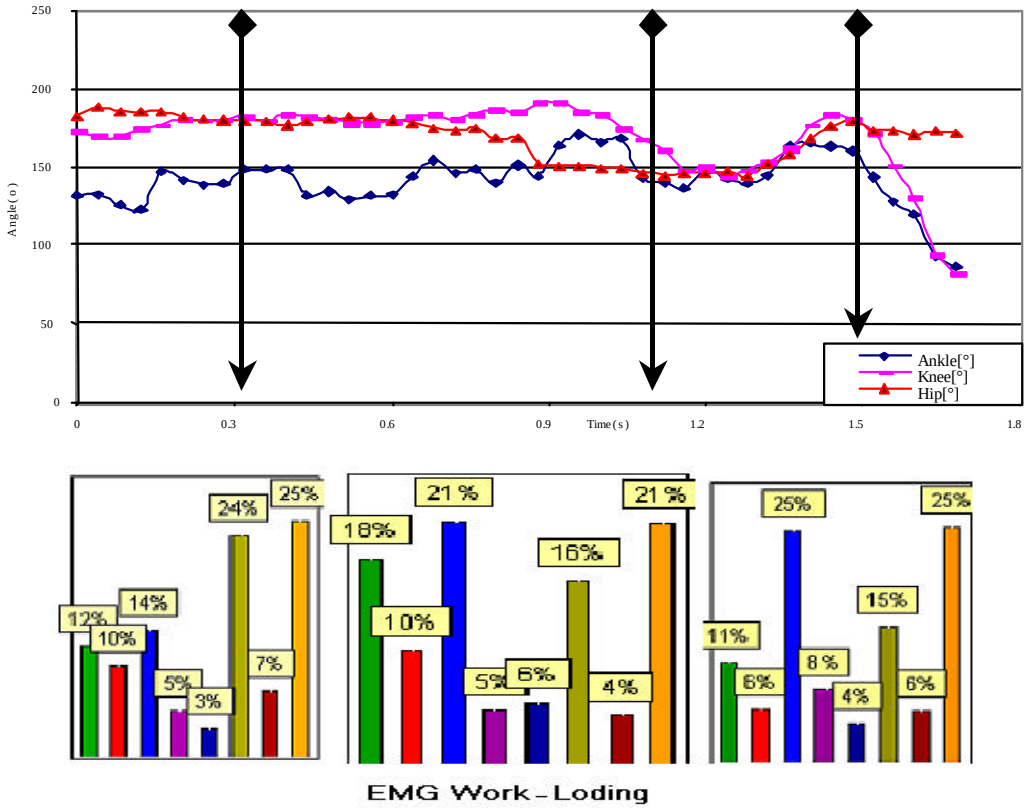

Fig. 4: Angular change for stick leg on trunk

Angular Change of the Striking Leg Joints and its Relation to the Electrical Muscle Activity "Participation Rates" of Performance on the Trunk

Preliminary Stage: As shown in Fig. 4, due to the nearness of kicking distance, a change has happened in the foot angle to reach 137° until it reached its highest level at the end of the preliminary stage of up to 150°. The angle of the knee has settled between close rates to a large extent, between 164° and 178° during the process of extending the knee to the front then pulled behind and to the top to proceed with the primary stage after that. For the hip angle, the recorded values were 172° at the beginning of this stage, up to 165° at the end of this stage because of pulling back to gain strength in the direction of stretching the leg forward and up. As for the electrical activity of muscles at this stage, the role of each of the " Multifidus" and "Quadriceps - middle fibers" of the fixed leg was demonstrated - Their participation rate was 24%, 25%, respectively, i.e. almost half the rate of participation and thus the core appropriation at this stage comes to the muscles also installed as performance on the face. The rest of the muscles recorded varying rates of participation "Quadriceps - middle fibers"14%, "Rectus Femoris"12%, "Quadriceps - inner fibers"10%, "Semitendinosus R" of the kicking leg 7%, "Quadriceps - outer fibers"5% and " Semitendinosus L" of the fixed leg 3%.

Primary Stage: The foot angle continued to decrease due to pulling the kicking leg back and to the top as the primary stage started with a value of 135° up and reached the highest value at the prime of the primary stage to 168° to continue decreasing by the end of the stage. Also the angle of the knee has decreased to reach the highest value of 180° during the kick then decreased to 150° before the final stage. The angle of the thigh has changed between 172° at the beginning of this stage and 147° by its end.

This is due to the nature of this skill performance on the trunk which is characterized by its strength and speed. As for the electrical activity of muscles at this stage, the role of "Quadriceps - middle fibers R, L" of the kicking leg showed a participation rate 21%. Also the rate of participation of "Tensor Fasciaelatae" was 18% and "Multifidus" was 16%.

Final Stage: It was noticed an increase at this stage in the angles of the joints of the kicking leg. The foot angle

recorded a value of 148° at the beginning of the final stage of rising up to reach 162° to continue to decline at the end of this stage to reach 88° when reaching the land. As for the angle of the knee, it continued to increase as a natural result of the process of the hip extension forward to reach the target and it is therefore natural technically for the knee and thigh to be extended to the front before resuming again withdrawn behind and confined down where the knee angle reaches between 146° at the beginning stage and 88° at the end stage. The angle of the thigh on the contrary continued in the angular stability as a technical precaution to preserve the balance of the player after kicking through transferring the body's center of gravity behind to maintain the balance of the body, making a large angle of the thigh at the end of the final phase of up to 170°. And as for the electrical activity of muscle activity, all the muscles in the lower thigh continued to participate and in particular Quadriceps - middle fibers of the kicking and fixed leg too, where the rate of participation was 25% for both.

CONCLUSION

The preliminary stage is the most important stage in performance, despite the extreme focus on the primary stage at learning and training. Delicate understanding of each stage during performing the investigated skill increases its success. The geometric path of the body's center of gravity for the investigated skill is the same at the two levels of performance; also the motor sequences of the stages is close during various performance stages and the stabilizing muscles play a significant role in performance; especially the middle fibers of Quadriceps.

RECOMMENDATION

Ensuring the focus should be on the nature of the muscle contraction according to "principle of specialization", the utmost focus during the training programs should be on the most participating muscles in the specialized muscle work.

Using the electrical muscular activity (EMG) to analyze the neural-muscular work when performing the various kinetic skills to obtain skill models which can help in evaluating and describing the skill performance.

Conducting further studies using the combination between the method of Electromyography and the motion analysis and applying their findings during the training process.

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