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Muscular Biomechanical Principles of Panchee Skill in Rhythmic Gymnastics

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Abstract

The research aims reaching the muscular biomechanical principles as an indicator to predict the excellence degree of performing the Panchee skill. The researcher used the descriptive survey method based on the biomechanical analysis. The sample was chosen by the Propulsive Sampling Technique from rhythmic gymnasts from Alexandria Sports Club "Sporting" which is one of the top clubs in rhythmic gymnastics. The sample consisted from one female gymnast. She's one of the best gymnasts in Egypt in rhythmic gymnastics. The most important working muscles in Panchee skill were conducted. Also, seven predictive equations were concluded. The researcher recommends focusing on these working muscles and the biomechanical principle. The researcher also recommends using the biomechanical and muscular analysis for building evaluation models during training in order to discover the mistakes and work on correcting them.

Keywords: Biomechanical Analysis, Gymnast, Evaluation Model

Introduction and Research Problem

The modern technology for the systems of biomechanical measurement is one of the basic fundamentals which helped sports training in making a great progress. This has resulted in the use of modern technological means in teaching motor skills, and sports training. The understanding process which based on a descriptive analysis of the biomechanical variables in motor sports is considered as a basic process in the sports training. (3: 41) (1: 134)

Studying the mechanics aspects of performance improves the performance. A proper use of mechanical principles is the basis to reach the highest level of motor and technical performance. (2: 14)) (7: 18))

Quantitative or qualitative analysis models are used in the field of biomechanics to solve kinetic problems related to the technical performance and to access to the most suitable technique for performing the skills. (12: 46, 47)

The electrical measurement in the field of sports is more accurate and objective comparing with the anatomical methods. Also, it is used to determine the working muscles in various skills and know the movements of the body parts. (10: 128)

Rhythmic gymnastics is one of the competitive sports. It is a sport where the gymnast may draw attention to her by her flexibility, strength and compatibility. (6: 3)

Balance skill is very important linking skill, and it's a high difficult skill, that must be covered by the motor techniques in rhythmic gymnastics, in accordance with the International Law of Rhythmic Gymnastics. (4: 105)

The researcher as well as reviewing the previous studies (Oumayma Ibrahim Ajami and Susan Salah al-Din Tantawi) and scientific references, she conducted an experimental study to analyze the results of the Olympic Games of rhythmic gymnastics, London (2012), in order to identify the percentage usage of Panchee skill in a comparison with the rest of balances. The study reached the following conclusions: Panchee skill has a recurrence rate in general was 83% and the percentage of recurrence in the combined skills was 75%. It had a great impact in achieving better results, while the performance of the Egyptian gymnasts characterized by hesitation and the international law stipulates that any performance must be stable and done on insteps and gymnasts must raise their heels up in order to calculate a complete point. This difficulty is worth 0.5 point. (5: 19)

So, the current study directed towards putting muscular biomechanical principles to perform Panchee skill in order to direct the training and preparation process of junior female gymnasts, and then determining the basic principles of preparing the upper levels gymnasts.

Research's Aim

reaching the muscular biomechanical principles as an indicator to predict the excellence degree of performing the Panchee skill, through:

1. The critical biomechanical indicators of the performance of the lower limb of Panchee skill in rhythmic gymnastics.

2. Electromyography characteristics of the used muscles in the performance of Panchee skill in rhythmic gymnastics.

3. The relationship between biomechanical indicators and the electrical activity of the working muscles through the stages of the Panchee skill in rhythmic gymnastics.

Research Questions

1. What are the critical biomechanical indicators of the performance of the lower limb of Panchee skill in rhythmic gymnastics?

2. What are the electromyography characteristics of the used muscles in the performance of Panchee skill in rhythmic gymnastics?

3. What are the contributing shares of the most important muscles of the lower limb through performing the Panchee skill in rhythmic gymnastics?

4. What are the muscular biomechanical principles of the Panchee skill in rhythmic gymnastics?

Research Procedures

Research Methodology: The researcher used the descriptive survey method based on the biomechanical analysis.

Research Sample: The sample was chosen by the Propulsive Sampling Technique (intentional) from rhythmic gymnasts from Alexandria Sports Club "Sporting" which is one of the top clubs in rhythmic gymnastics. The sample consisted from one female gymnast. She's one of the best gymnasts in the Arab Republic of Egypt in rhythmic gymnastics.

Tools and Means of Data Collection:

The data of the research was collected through:

(a) Anthropometric measurements

(b) Using a video camera and a biomechanical analysis with (Win Analysis).

(c) Electrical analysis of the working muscles' activities by the EMG device.

(d) A Form of fvaluating the technical performance of Panchee skill

Figure 1

Phases	Performance	Degree	Degrees Sum
Preliminary Phase	Instep of the Pivot Leg is Out	0.5	
	Knee of the Pivot Leg is Out	0.5	
	with the legsºLeaning the Truck forward till make 90	0.5	
	Moving the Free Leg backward steadily	0.5	
	Sum of the Preliminary Stage		2.00 degrees
Main Phase	Lifting Ankle of the Pivot Leg	0.5	
	Ankle of Pivot Leg is Straight	0.5	
	Instep of the Free leg is Outward	0.5	
	Free Leg is in Panchee Position	1.00	
	Staying Stable in Panchee Position	2.00	
	Staying Stable for 2-3 seconds	1.50	
	Sum of the Main Stage		6.00 degrees
Final Phase	Head is Forward	0.5	
	Dropping the Free leg steadily	0.5	
	Backing to the Initial Position Steadily	1.00	
	Sum of the Final Stage		2.00 degrees
	Sum of the Skill Degrees		10 Points

Exploratory Study

The researcher reviewed the previous studies and determined the working muscles.

Procedural Steps of the Main Study

In the light of the results of previous studies and exploratory studies, the points of the main study were identified as the following:

- Determining the biomechanical variables resulting from the kinetic analysis.

- Identifying the most important moments of time.

- Determining the electrical variables of the activity of muscles from the EMG device.

Statistical Treatments:

The following statistical methods were used through the SPSS program because of its suitability of the nature of the study:

- Mean

- Maximum value

- Minimum value

- Percentage

- Standard deviation

- Skewness coefficient
- Factor analysis
- Multi-correlation coefficient
- Multiple linear regressions
- Predictive equation of performance degree.

Presentation and Discussion of the Results

The most contributed muscles in the performance with the maximum contraction in a comparison with the rest of right leg's muscles (Leg Pivot), according to the largest value of the electrical activity and arithmetic mean are respectively: Gastrochemius –medial part, followed by Extensors of the ankle and soleus and Tibialis Anterior. This group of muscles involved in making a balance of the body on the pivot foot as well as these muscles help in the extension of the knee joint, and that these muscles are in a maximum activity when the knee is extended.

Also Gastrochemius –lateral part muscle does a Planter Flexion of the ankle joint; from here we find that there is an overload on these muscles, because it requires high strength and high stability in order to count a point, according to the law of the game. (5: 210, 223)

The Gastrochemius –medial part muscle also contributes in the Planter Flexion of the ankle joint because of its importance in helping the female gymnast standing on the instep, heels up, with a help of the soleus muscle by preventing the body from falling forward.

Increasing in the muscular effort happens when the gymnast's heels goes up farther from the pivot point and stands on a small area (instep). (6: 128)

According to the free leg (left), we find that the most muscles contribute in the performance according to the arithmetic mean and the largest value of the electrical activity are respectively: Gastrochemius –medial part muscle and Gastrochemius –lateral part muscle followed by Rectus Femoris muscle finally Vastus Medialis muscle.

The researcher believes that the mentioned muscles are the most contribution muscles in the performance while the rest of muscles have a less contribution in the performance, so the sequence and integration will happen between all muscles. Stability and balance are achieved by the availability of power of the two legs, used or free, and it was confirmed by both Arthur & et.al (2008)(4), Susan and Jasmine (2004) (6).

Ne'mat Abdel Rahman and Magda Ragab (2003) that when performing Panchee skill the gymnast must swing the leg strongly to reach the vertical position to overcome the resistance of gravity. (9 : 78-80)

To keep the center of gravity of the body above the pivot base center, the gymnast must have powerful two legs tom maintain his balance. (8: 34, 35)

Table 1
Statistical variable of the Technical Evaluation of Panchee Skill in Rhythmic Gymnastics

Statistical Variables	Min. Value	Max. Value	Mean	Standard Deviation	Skewness Coefficient
Technical Evaluation (degree)	8.500	9.55	9.00	0.500	.000

Table 2
Multi Regressions Analysis by Step Wise Method of Biomechanical Variables in the Technical Stages of Panchee Skill in Rhythmic Gymnastics

Indicators	Multi Linear Regressions	B		Standard Deviation of B	(Beta) Standardized Coefficients	T value	Significant Level	R^2
1	A	Constant	13.881	1.192		11.644*	0.00	0.924
	X1	Tilt Angle Trunk	-0.081	0.009	-0.961	-9.226*	0.00	

$\hat{Y}$ = a + b1x1

Where $\hat{Y}$ = Performance Degree

A = constant

b1 = B

X1 = the arithmetic mean value of the tilt angle of the trunk

$\hat{Y}$ = constant + B × arithmetic mean value of the tilt angle of the trunk

Predictive equation of performance degree of Panchee Skill by knowing the biomechanical variables is:

Performance degree of Panchee Skill = 13.881 + (- 0.081) × 133.778

Table 3
Multi Linear Regression Analysis by Step Wise Method of the Biomechanical and Electrical Activity (EMG) Variables of Working Muscles of Panchee Skill Stages

Variables	Linear Multi Regression Model		B	Standard Deviation of B	(Beta) Standardized Coefficients	T value	Significant Level	R^2
1	A	Constant	13.881	1.192		11.644*	0.00	92.4%
	X1	% M7	-0.081	0.009	-0.961	-9.226*	0.00	
2	A	Constant	8.672	1.871		4.634*	0.004	97.1%
	X1	% M7	-0.068	0.007	-0.799	-9.121*	0.00	
	X2	Max M2	0.675	0.219	0.270	3.081*	0.022	
3	A	Constant	7.861	1.237		6.357*	0.001	99.00%
	X1	% M7	-0.061	0.005	-0.716	-11.419*	0.00	
	X2	Max M2	0.799	0.147	0.320	5.434*	0.003	
	X3	Max M12	-0.616	0.201	-0.154	3.065*	0.028	

It's clear from table (3) that there are significant differences in the value of (T) in the variables of (1,2,3) forms. Contribution percentage of this forms are (92.4 %, 97.1 %, and 99%) in the performance evaluation

Y = a + (b 1. x1)

$\hat{Y}$ = 13,881 - 0,081 × mean value of tilt angle of the trunk

- Evaluation Degree of performance in the second basis $\hat{Y}$:

$\hat{Y}$ = 8.672- 0.068 × mean value of tilt angle of the trunk + 0.675 × Contribution Percentage of Rectus Femoris muscle M9 (4.7%)

- Evaluation Degree of performance in the third basis $\hat{Y}$:

$\hat{Y}$ = 7.861 - 0.061 × mean value of tilt angle of the trunk + 0.799 × Contribution Percentage % of M9 muscle (4.7%) - 0.616 × Contribution Percentage % of M13 (Extensors muscles of the ankle) (1.9%)

Hence, we find that the muscular biomechanical principles of the Panchee skill can help in the selection and training process in Rhythmic Gymnastics to ensure the highest level of performance and it agrees with the studies of Oumayma Ajami and Susan Tantawy (2009)(11)

The Most Important Conclusions

In light of the research's sample and limits of used tools, scientific references and statistical treatments; the researcher concluded the following:

First: Predictive equation of evaluation degree of Panchee skill, in accordance with the biomechanical principles:

- Evaluation Degree of performance = constant amount (13.881) + B (-3.881) × mean value of tilt angle of the trunk.

Second: Predictive equation of evaluation degree of Panchee skill, in accordance with the electrical activity principles:

- Performance Degree in the first basis = -1.979 + 0.390 × contribution Percentage of M7% (Right Gastrochemius – medial part Muscle) (0896)

- Performance Degree in the second basis = -1.122 + 0.380 × contribution Percentage of M7% (Right Gastrochemius –medial part Muscle) (0.988) -0.002 × Max. Value of (M2) (Right Vastus Lateralis) (0.889)

- Performance Degree in the third basis= -4.254+ 0.502 × contribution Percentage of M7% ((0.996) – 0.002 × Max. Value of M2 Muscle (0.889) + 0,003 × 0.901 (Max. M12) (Left Tibialis Anterior Muscle)

Third: Predictive equation of evaluation degree of Panchee skill, in accordance with the muscular biomechanical principles:

- Evaluation Degree of performance in the first basis $\hat{Y}$ = constant value (13,881) + Incline B (-0.01)(mean value of tilt angle of the trunk

- Evaluation Degree of performance in the second basis $\hat{Y}$ = constant value 8.672- + Incline B (-0.068) × mean value of tilt angle of the trunk + Incline B (0.675) × Contribution Percentage of Rectus Femoris muscle M9

- Evaluation Degree of performance in the third basis $\hat{Y}$ = constant value (7.861) + Incline B (- 0.061) × mean value of tilt angle of the trunk + Incline B (0.799) × Contribution Percentage % of M9 muscle + Incline B (-0.616) × Contribution Percentage % of M13 (Extensors muscles of the ankle).

These equations are excellent; so, we find that the contribution percentage of the first model is 92.4 %, the contribution percentage of the second model is 4.7%, and the contribution percentage of the third model is 1.9%

Thus, the contribution percentage of the three models together is 99%.

So, we can use these equations as a guide for the biomechanical principles of Panchee skill.

The Most Important Recommendations

- When planning training programs, we should focus on the most contributed muscles in Panchee skill.

- Using the biomechanical and muscular analysis for building evaluation models during training in order to discover the mistakes and work on correcting them.

- It's possible to Assess Panchee skill through the statistical biomechanical models.

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