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Developing Specific Exercises through Studying Electrical Activity of some Muscles Working on the Lower Limb during Triple Jump Competition.**Dr. Magda Nagy Nasr****Assistant professor, Department of Sports Training and Movement Sciences, Faculty of Physical Education for Girls, Alexandria University, Egypt.****Abstract**

Technological development have a big share in kinematic analysis, as in measuring muscle electrical activity, in detection of inter-relationships between body parts of the body while performing those skills. This could not be obtained without follow-up and analyze player movements during skills' performance phases .

Exercises which are similar to skills performance nature should be similar in motor composition with movements performed by player within sports competition in terms of force, speed, force time path, muscular work direction and with movements performed, i.e. characterized with existence of dynamic match between its the path and motor technique path using the same working muscle groups in the same skill .

Exercise which is characterized by privacy in the development of physical and motor abilities, in certain muscles in the body, where it works on the immediate focus on working muscles and improve muscle tone and timing of contraction and extraversion necessary for sound performance; that indicate using specific exercises importance to upgrade skills performance level in various sports activities, these exercises serve skills performance and improve neuromuscular path of its performance.

Researcher in the opinion that determine specific exercise through analysis using (EMG) and mechanical analysis work to give coaches the opportunity to choose - on scientific grounds - specific exercises associated with activity practiced, where it is difficult to make the equipment available for coaches, so the researcher analyzed the competition for Egypt champion under 18 years in triple jump, as well as propose a set of exercises that are similar to performance, analyze and compare the performance of triple jump to determine the most important specific exercises related to performance. Determining working muscle in practiced activity helps coaches too much on developing sound training programs, which aimed to develop functional status of these muscle specifically.

The most important results include that the most important muscle are Quadriceps femoris muscle - vastus lateralis, Quadriceps femoris muscle - vastus medialis, Gastrocnemius muscle - lateral part, and Tibialis anterior muscle and that That most important muscles working in (1st and 2nd) exercises vastus are Quadriceps femoris muscle - vastus lateralis, Quadriceps femoris muscle - vastus medialis, Gastrocnemius muscle - lateral part, Tibialis anterior muscle and Quadriceps femoris muscle - rectus femoris which are the same working muscles in triple jump and almost with the same of maximum contraction values. Working muscles (3rd, 4th and 5th) were Quadriceps femoris muscle - vastus lateralis, Quadriceps femoris muscle - vastus medialis, Gastrocnemius muscle - lateral part, and Tibialis anterior muscle

Introduction:

Developed countries were able to reach the optimal use of players' abilities within each phase of skill technical performance phases through specific exercises which are similar of movements in its composition, requirements, work direction, muscles contractions prevailing in working muscle groups in it with those movements that done through performance, which leads to economy in the time and effort until reaching mastery of motor skills in activity type. (Khairia ELSokry, Mohammed Briqa, 2010: p79)

Abul Ela Abdel Fattah, Mohamed Sobhy Hassanein (1997, P35) noted that technological development have big shares in kinematic analysis, in measuring muscle electrical activity, in detection of the inter-relationships between parts of the body while performing those skills. This could not be

obtained without follow-up and analyze of player movements during skills' performance phases.

Talha Hussein, Mohammed Abdel-Rahman (1989, p36-37) argue that using anatomical analysis for muscular system is one of the scientific methods to study muscles contact locations and their relationship with joints; also it helps coach to identify the most important muscles that work positively to perform a movement; so the coach can - through this knowledge - develop muscles function in an appropriate manner; which in turn makes player able to perform and progress to optimal level

Electromyography (EMG) is working to find out contribution extent of each working muscle's in the movement, as well as the changes occur in muscles during acquiring motor skills .

Talha Hossam El Din (1994, p17-18) confirm the importance of specific exercises, which means that kind of exercise, which is characterized by privacy in the development of physical and motor abilities, in certain muscles, where it works on the immediate focus on working muscles and improve muscle tone and contraction timing and extraversion necessary for sound performance; that indicate using specific exercises is important to upgrade skills performance level in various sports activities, these exercises serve skills performance and improve its performance neuromuscular path.

Mohamed Hassan Allawi (1990, p294) and Essam Abdel-Khalek (1994, p18) in the opinion that exercises which are similar to skills performance nature are similar in motor composition with movements performed by player within a sports competition in terms of force, speed, force time path, muscular work direction and with movements performed, i.e. characterized with existence of dynamic match between its the path and motor technique path using the same working muscle groups in the same skill.

Triple jump consists of the following stages: approach, hop, step and jump. Each of hop, step, and jump consists of takeoff, flight and landing. (4: 88). Qassim Hassan (1999, p335) indicates that triple jump is made from approaching and three interconnected jumps where takeoff force plays major role in the jump. Bastawisy Ahmad (1997, p318-319) also confirms that force and speed elements represent a positive and important role in triple jump for three jumps in a row with different rhythms, this means a difference in mechanical foundations application which affect achievement level of the three jumps. Therefore it should be taken into account to get the proper angle whether at setting foot, or while impulse at take-off stage, to get center of gravity at the highest speed ratio, coupled with the most appropriate angle of flight, center of gravity should arrive to appropriate flight height to achieve the greatest possible distance.

After examining scientific literature, previous studies and what has been obtained from the internet; the information associated with research matter indicate that there are many studies used plyometric exercises training programs to develop muscle force as studies of Samir Abbas, Omar Abdel Moneim, Ibrahim Hareedy (1987), which studied the effect of two methods of plyometric exercises on the relative force for lower limb and six hops distance and time, Osama Mohammed Abu Tabl (1999), which studied the effect of plyometric exercises standardization using ability analysis on some dynamic performance variables in triple jump competition, Ahmed Saad, Osama Abu Tabl (2008), which focused on combining plyometric training with electrophoresis on some muscle strength characteristics and record level at triple jump races (3). Some studies used training programs to develop muscle strength in horizontal and vertical direction as studies of: Mohamed Shawky Sibai, Amr Allah Bisatti (2002), Mohamed Mohamed Abdel Aal, Abdel Moneim Ibrahim Hareedy, ElSayed Shehata Ahmed (2001), Yu Ping (1999), Abdel Moneim Ibrahim Hareedy,

Ahmed Saad Eddin Mahmoud (1999), which examined development of muscle strength in several knee joint angles and its impact on achievement of the triple jump competition " .

JARMO et al (2000) study was designed to assess neuromuscular work through muscles electrical activity in the triple jump competition using (EMG), W. Kakihana Suzuki & S. Suzuki (2001) study aimed to describe land reaction through (EMG) and kinematic variables during takeoff in different angles in triple jump, Walker. S, et al (2011) study aimed to compare fixed and variable resistors repetition using group loads, speeds and contractions, Cassie.W, et al (2009) studied kinetic models for triple jump exercises and aimed to determine the effectiveness of training on lower limb exercises models used for triple jump .

In light of what mentioned above, the researcher in the opinion that determine specific exercise through analysis using (EMG) and mechanical analysis work to give coaches the opportunity to choose - on scientific grounds - specific exercises associated with sport activity practiced, where it is difficult to make the equipment available for coaches, so the researcher analyzed the competition for Egypt champion under 18 years in triple jump, as well as propose a set of exercises which are similar to performance, analyze and compare the performance of triple jump to determine the most important specific exercises related to performance, as determining working muscle in practiced activity type helps coaches too much on developing sound training programs, which aimed to develop functional status of these muscle specifically .

Research objectives :

- 1- Identify the electrical activity of some lower limb muscles to improve take off phase (hop - step - jump) in the triple jump competition .
- 2- Suggestion quality exercises to improve takeoff phase (hop - step - jump) in the triple jump competition .
- 3- Identify the electrical activity of some lower limb muscles in takeoff phase (hop - step - jump) in the proposed exercises .
- 4- Identify the most important specific exercises involving muscles that work in takeoff phase (hop - step - jump) for the triple jump competition .
- 5- Identify some biomechanics variables for Egypt champion under 18 years in takeoff phase (hop- step - jump) and their relationship to electrical activity of some lower limb muscles of triple jump competition.

Research queries :

- 1- What is the relative importance of some lower limb muscles to improve take off phase (hop - step - jump) in the triple jump competition?

- 2- What is the relative importance of some lower limb muscles in takeoff phase (hop - step - jump) in the proposed exercises?
- 3- What are the working muscles in takeoff phase (hop - step - jump) for the triple jump competition?
- 4- What are the biomechanics variables for Egypt champion under 18 years in takeoff phase (hop- step - jump) and their relationship to electrical activity of some lower limb muscles of triple jump competition.

Research procedures :

I- Research Methodology :

The researcher used descriptive approach with muscle activity analysis and mechanical analysis due to its relevance to the nature of this search .

II- Research Sample

Selected intentionally Egypt champion (female) under 18 years in the triple jump and the player at Alexandria military establishment Club for year 2012 .

Table (1)
player's Data

Name	Reham Hamdy
Hight	171 cm
Weight	59 kg
Date of birth	Sept 18 th , 1997
Years of training	5 years
Record	11.81 m

III- Research Tools :

- Muscle electrical drawing device (EMG) Wireless with 16-channel .
- 2 video camera (one for analysis of muscles' electrical activity and the other for kinematic analysis) with frequency of 25 cadre / sec .

Analysis instruments and devices represented in

1- Siemens computer device contains :

- Kinetic Analysis Software and includes three main programs :
 - A- Streampix recording software
 - B- AVI Editing program
 - C- Win analyze 2 dimension 2D

2- Computer. 3 - Laser printer .

- Restameter for height measurement to nearest 0.5 cm .
- Different height barriers 30 cm, 40 cm, jump box, Medical balls Weight 2 kg, boxes with height of 17 cm .

- Medical scale to measure weight to the nearest 0.5 kg .

III- Pilot study :

Pilot study conducted for vedigraph competition and proposed exercises under discussion :

Pilot study had been applied on 4th grade student, Department of track and Field, Faculty of Physical Education for Girls, Alexandria University, who are not in main study sample, this study was conducted on Saturday May 26th, 2012 at 11 am in track and field land in faculty Physical of Physical Education for Girls, Alexandria University, in order to :

- Ensure the validity of land area that will be used .
- Determine cameras location, speed and height positions .
- Make sure that the cameras are perpendicular to motion field and include overall movement area .
- Identify drawing scale .
- Detection of problems that may appear during videography to avoid any error .
- Make sure that assistants know how to use measuring instruments .

The results revealed:










- Ensuring safety and efficiency measurement tools.
- Muscle Electric Analysis camera (1) and its videography area of takeoff , flight and landing phases (16.85 m) and height of the camera (1.35 m) above the ground
- Muscle mechanical analysis camera (2) and videography area (17.90 m) and camera height (1.40 m) above the ground .
- Drawing scale has been developed with 5 meters length.
- Some colleagues from faculty members worked as assistants .

IV- Main study

1- Videography area preparation and player preparation for videography

- Videography place prepared as per pilot study results, and carried out at 11 am in track and field competition land at Faculty of Physical Education for Girls, Alexandria University, player (research sample) was prepared by fixing electrodes (EMG) consisting of three poles for each muscle put on muscle's half, taking into account cleaning skin by ethyl alcohol, as well as put adhesive labels on anatomical points of player body joints .

- Explained purpose of electrophoresis analysis to player (research sample) and measurement method so as to remove fear factor of electrical connections of the device, as well as to explain the proposed exercises for the player and the steps that will pass with surrounding imaging performance to be a sense as if it were in an actual match. and has the imaging process synchronous between a (EMG) and biomechanics videography analysis, working muscles have been identified based on anatomical analysis by dividing the movement to major phases determining joints that share in motion performance, determine the active muscle as well as from previous studies : Jarmo et al (2000), study Walker. S, et al (2011) study Kakeinana W. & Suzuki S. (2001)




	4L:Quadriceps femoris muscle - rectus femoris
	5R:Quadriceps femoris muscle - vastus lateralis
	6R:Quadriceps femoris muscle - vastus medialis
	7 R:Gastrocnemius muscle - lateral part
	8 R:Tibialis anterior muscle
	9 L:Quadriceps femoris muscle - vastus lateralis
	10 L:Quadriceps femoris muscle - vastus medialis
	11 L:Gastrocnemius muscle - lateral part
	12 L:Tibialis anterior muscle

Player (research sample) was filmed during her performance of triple jump, as well as ead proposed exercises (training modules for each of hop, step and jump), which have been identified from references and previous studies to fit the training, It has been taken into account that proposed exercises should match triple jump movement path, also takes into account that the land to be of tartans even for player’s safety and security and final number of exercises were final five which is :

First exercise: medical ball + medical ball+ 30 cm height barrier

Table (2)

Lower limb working muscles of each of (hops, step and jump) for the triple jump competition

	1R:Gluteus maximus muscle
	2R:Quadriceps femoris muscle - rectus femoris
	3 L:Gluteus maximus muscle



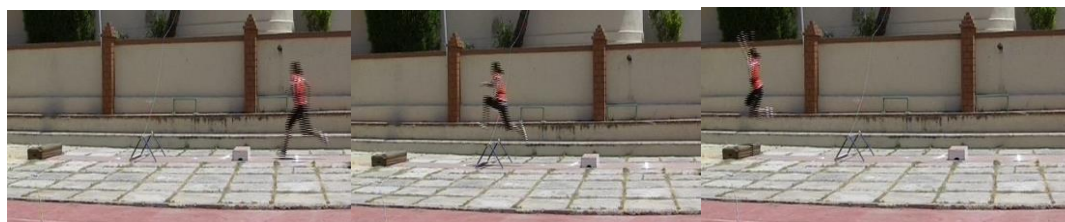
Second Exercise: medical ball + 30 cm height barrier + 40 cm height barrier .



Third Exercise: three 30 cm. height barriers



Fourth Exercise: 17 cm height stop+ 40 cm height barrier + 17 cm height stop .



Fifth exercise: 17 cm height stop + empty + jump ladder .



The player has three performance attempts after a good warm-up , the best attempt has been chosen to motor and muscle analyze, researcher has taken into account not straining the player until the results of the analysis is not affected as a result of muscular fatigue .

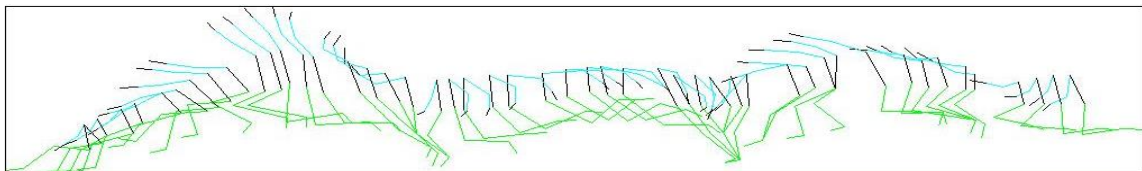
Electrical analyzing process as well as the kinematic analysis carried out at mechanical lab, Faculty of Physical Education for Girls, Alexandria University, prepared for motor analysis to extract all variables associated with the research, which has been exported automatically to Excel (MS office program), as well as downloading filmed attempts from camera to computer for kinetic analysis to extract data required .

2- Second: electrical activity and kinetic analysis :

VI - Results and discussion:

1- First query results

Figure (1)
illustrates the takeoff stage of each of (hop, step and jump) for the triple jump competition



Hop in the main attempt step in main attempt jump in main attempt

Table (3)
Maximum contraction and muscle contribution rates in takeoff stage of (hop, step and jump) for the triple jump competition

Triple jump attempt	(Hop)		(step)		(jump)		Measurement unit Micro volt uvs
	Maximum contraction	%	Maximum contraction	%	Maximum contraction	%	
Muscles	Max	%	Max	%	Max	%	
1R:Gluteus maximus muscle	5 uv	3%	5uv	1%	26uv	4%	
2R:Quadriceps femoris muscle - rectus femoris	19uv	77%	50uv	5%	14uv	4%	
3 L:Gluteus maximus muscle	26 uv	3%	24uv	3%	7uv	2%	
4L:Quadriceps femoris muscle - rectus femoris	11 uv	2%	11uv	2%	35uv	5%	
5R:Quadriceps femoris muscle - vastus lateralis	256 uv	19%	1333uv	19%	39uv	11%	
6R:Quadriceps femoris muscle - vastus medialis	81 uv	5%	42uv	6%	41uv	4%	
7 R:Gastrocnemius muscle - lateral part	98 uv	5%	21uv	3%	34uv	9%	
8 R:Tibialis anterior muscle	149 uv	13%	98uv	15%	62uv	18%	
9 L:Quadriceps femoris muscle - vastus lateralis	83 uv	8%	37uv	3%	33uv	8%	
10 L:Quadriceps femoris muscle - vastus medialis	100 uv	65%	36uv	5%	64uv	14%	
11 L:Gastrocnemius muscle - lateral part	243 uv	19%	176uv	23%	31uv	7%	
12 L:Tibialis anterior muscle	300 uv	14%	134uv	16%	51uv	14%	
Overall work space	681uvs		128 uvs		335uvs		

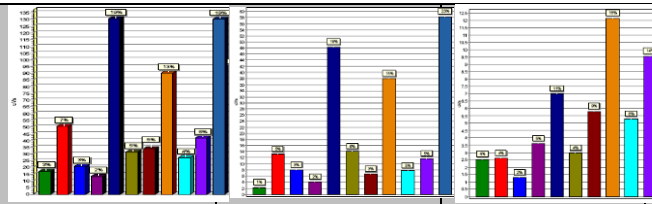


Table No. (3) show that the highest contribution percentage of muscles working in (Hops) was the Quadriceps femoris muscle - vastus lateralis where it reached the maximum contraction of 256uv (19%), followed by L:Gastrocnemius muscle - lateral part 243uv (19%), while the lowest rate was for Gluteus maximus muscle with maximum contraction 5uv (3%).

Same table results indicate that highest percentage contribution of muscles working in (Step) were L:Gastrocnemius muscle - lateral part left 171 uv (23%) followed by 5R:Quadriceps femoris muscle - vastus lateralis 133uv (19%) while the muscle contribution was working for Gluteus maximus muscle 5uv with rate (1)% .

Same table results shows also that the highest working muscle contribution working in (jump) were R:Tibialis anterior muscle with maximum contraction 62uv(18%) followed by L:Quadriceps femoris muscle - vastus medialis 64uv (14%); while lowest contribution rate was :Gluteus maximus muscle 7uv (2%).

Results showed that highest electrophoresis values was in step, muscle electrical activity in hop 681uvs uvs, while in step 128 uvs Micro Vault, and in jump 335 uvs .

2- First query discussion:

Results were discussed based on the results of variables associated with muscle electrical activity analyze of the triple jump competition and specific exercises and compare some of the results of previous studies and references related to the this research matter, and discuss the results according to research queries .

Table (3) results reveal that highest contribution percentage in (hop, and step) was for Quadriceps femoris muscle - vastus lateralis then L:Gastrocnemius muscle - lateral part , followed by :Tibialis anterior muscle; while in (jump) were R:Tibialis anterior muscle followed by L:Quadriceps femoris muscle - vastus medialis then L:Tibialis anterior muscle followed by R:Quadriceps femoris muscle - vastus lateralis

And so we find that the high amount of electrical activity of these muscles during takeoff phase demonstrates the importance of training these muscle to contract the joints of takeoff leg, as shown by results of measuring muscles' electrical activity during performance of each of hop, step and jump in triple jump that the highest values of electrophoresis activity was in step, then jump followed by hop. This interpretation is consistent with the principles

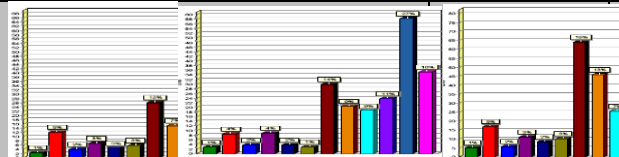
associated with muscle composition and functional nervous system where muscle to contract more forcefully if it is placed in the case of prolonging before the start of the contraction. (Talha Hussain, 1994 :p13)

From the above, we find that the most important muscle are R:Quadriceps femoris muscle - vastus lateralis, R:Quadriceps femoris muscle - vastus medialis, R:Gastrocnemius muscle - lateral part , R:Tibialis anterior muscle, L:Tibialis anterior muscle, and R:Quadriceps femoris muscle - rectus femoris and this was confirmed by JARMO et al (2000, p236) study that the most important

muscle is the calf muscles, and Quadriceps femoris muscle muscles and hip flexor, which play an important role in pushing (24: 336), Walker and others Walker et al (2011, p262-269) proofed that the most important muscle are R:Quadriceps femoris muscle - vastus lateralis, 6R:Quadriceps femoris muscle - vastus mediali and 2R:Quadriceps femoris muscle - rectus femoris (26 :262-269) and one of the most important results of W. Kakihana & S. Suzuki (2001) study the confirmation that these muscles that give greater impulse force at takeoff moment and this answer first query.

3- Second and third queries results

Table (4)
Maximum contraction and muscle contribution rates in takeoff stage of (hop, step and jump) for first exercise

Figure shows working muscle in takeoff phase (hop, step, jump)						
	(Hop)		(step)		(jump)	
First exercise	Maximum contraction	%	Maximum contraction	%	Maximum contraction	%
Muscles	Max	%	Max	%	Max	%
1R:Gluteus maximus muscle	5uv	1%	5uv	1%	12uv	2%
2R:Quadriceps femoris muscle - rectus femoris	40uv	7%	22uv	4%	41uv	5%
3 L:Gluteus maximus muscle	10uv	2%	7uv	2%	10uv	2%
4L:Quadriceps femoris muscle - rectus femoris	13uv	3%	19uv	4%	19uv	3%
5R:Quadriceps femoris muscle - vastus lateralis	66uv	4%	7uv	2%	22uv	2%
6R:Quadriceps femoris muscle - vastus medialis	37uv	4%	9uv	1%	27uv	3%
7 R:Gastrocnemius muscle - lateral part	63uv	12%	59uv	14%	275uv	21%
8 R:Tibialis anterior muscle	93uv	6%	45uv	9%	181uv	15%
9 L:Quadriceps femoris muscle - vastus lateralis	40uv	6%	50uv	9%	85uv	7%
10 L:Quadriceps femoris muscle - vastus medialis	46uv	9%	48uv	11%	53uv	7%
11 L:Gastrocnemius muscle - lateral part	174uv	32%	127uv	27%	172uv	19%
12 L:Tibialis anterior muscle	108uv	19%	77uv	16%	138uv	16%
Overall work area	106uvs		216 uvs		243 uvs	

Measurement unit
Micro volt uvs

Table (4), indicates that the maximum contraction and contribution rates for working muscles for (Hops) were for L:Gastrocnemius muscle - lateral part with maximum contraction 174uv(32%), followed by L:Tibialis anterior muscle 108uv (19%), while the lowest rates of contribution to the muscles working was R:Gluteus maximus muscle 5uv (1%),

Same table results also indicate that highest contribution for working muscles in (Step) were L:Gastrocnemius muscle - lateral part with maximum contraction 127uv (27%) followed by L:Tibialis anterior muscle 77uv (16%), while

the lowest muscle contribution were R:Gluteus maximus muscle 5uv (1%).

Table results also indicates that highest contribution percentage for working muscles in (Jump) were R:Gastrocnemius muscle - lateral part with maximum contraction 275uv (21%) followed by L:Gastrocnemius muscle - lateral part 172uv (19%), while the working muscles lower contribution rates were Quadriceps femoris muscle - rectus femoris where 10uv (2%).

Results indicate that during first exercise highest values of electrophoresis activity was in the jump , with muscle

electrical activity values of 243 uvs, while values were in step 216 uvs, and in hop 106uvs.

Table (5)
Maximum contraction and muscle contribution rates in takeoff stage of
(hop, step and jump) for second exercise

Second exercise	Figure shows working muscle in takeoff phase (hop, step, jump)					
	(Hop)		(step)		(jump)	
	Maximum contraction	%	Maximum contraction	%	Maximum contraction	%
Muscles	Max	%	Max	%	Max	%
1R:Gluteus maximus muscle	22uv	4%	11uv	3%	6uv	1%
2R:Quadriceps femoris muscle - rectus femoris	71uv	13%	14uv	4%	66uv	6%
3 L:Gluteus maximus muscle	34uv	5%	7uv	2%	27uv	4%
4L:Quadriceps femoris muscle - rectus femoris	15uv	3%	43uv	9%	19uv	2%
5R:Quadriceps femoris muscle - vastus lateralis	41uv	11%	16uv	3%	184uv	11%
6R:Quadriceps femoris muscle - vastus medialis	44uv	10%	16uv	3%	18uv	3%
7 R:Gastrocnemius muscle - lateral part	53uv	10%	34uv	7%	88uv	11%
8 R:Tibialis anterior muscle	86uv	17%	71uv	13%	60uv	9%
9 L:Quadriceps femoris muscle - vastus lateralis	19uv	4%	61uv	13%	55uv	6%
10 L:Quadriceps femoris muscle - vastus medialis	45uv	8%	26uv	7%	36uv	4%
11 L:Gastrocnemius muscle - lateral part	43uv	6%	67uv	17%	206uv	23%
12 L:Tibialis anterior muscle	85uv	10%	73uv	18%	145uv	20%
Overall work area	131uvs		161 uvs		258 uvs	

Measurement unit
Micro volt uvs

Table No. 5 results reveal that working muscles highest contribution percentage in (Hop) were R:Tibialis anterior muscle where the maximum contraction of her 86uv (17%), followed by Quadriceps femoris muscle - rectus femoris 71 uv (13%), while the lowest rates of working muscles contribution was Quadriceps femoris muscle - rectus femoris with maximum contraction 15 uv (3%).

Same table also indicates that working muscles highest contribution percentage in (Step) were L:Tibialis anterior muscle where maximum contraction was 73 uv (18%), followed by L:Gastrocnemius muscle - lateral part 67uv(17%) , while working muscles lower contribution rate was Gluteus maximus muscle with maximum contraction 11 uv (3%).

Same results also indicate that working muscles highest contribution percentage in (jump) were L:Gastrocnemius muscle - lateral part with maximum contraction 206uv (23%) followed by L:Tibialis anterior muscle 145uv (20%), while lower contribution rate was R:Quadriceps femoris muscle - rectus femoris with maximum contraction 6uv (1%).

The electrical activity results during second exercise performance show that highest electrophoresis activity value was in jump with 258 uvs Micro Vault, while of electrical activity value in step were 161 uvs Micro Vault, and in hop 131uvs the Micro Vault.

Table (6)
Maximum contraction and muscle contribution rates in takeoff stage of
(hop, step and jump) for third exercise

Third exercise	Figure shows working muscle in takeoff phase (hop, step, jump)					
	(Hop)		(step)		(jump)	
	Maximum contraction	%	Maximum contraction	%	Maximum contraction	%
Muscles	Max	%	Max	%	Max	%
1R:Gluteus maximus muscle	30uv	0%	85uv	1%	609uv	4%
2R:Quadriceps femoris muscle - rectus femoris	84uv	1%	220uv	4%	455uv	7%
3 L:Gluteus maximus muscle	33uv	0%	458uv	6%	270uv	3%
4L:Quadriceps femoris muscle - rectus femoris	39uv	0%	379uv	7%	377uv	5%
5R:Quadriceps femoris muscle - vastus lateralis	4158uv	20%	283uv	5%	542uv	6%
6R:Quadriceps femoris muscle - vastus medialis	5321uv	27%	2305uv	25%	5456uv	30%
7 R:Gastrocnemius muscle - lateral part	4193uv	21%	507uv	9%	718uv	5%
8 R:Tibialis anterior muscle	4283uv	26%	384uv	9%	464uv	6%
9 L:Quadriceps femoris muscle - vastus lateralis	104uv	2%	760uv	13%	494uv	8%
10 L:Quadriceps femoris muscle - vastus medialis	42uv	0%	532uv	10%	426uv	7%
11 L:Gastrocnemius muscle - lateral part	45uv	0%	378uv	5%	832uv	11%
12 L:Tibialis anterior muscle	70uv	1%	459uv	6%	689uv	8%
Overall work area	2079 uvs		1106 uvs		2787uvs	

Measurement unit
Micro volt uvs

Table (6) results reveal that working muscles highest contribution percentage in (Hop) were R:Quadriceps femoris muscle - vastus with maximum contraction 5321uv (27%), followed by R:Tibialis anterior muscle maximum contraction 4283uv (26%), while the lowest working muscles contribution rate were Gluteus maximus muscle with maximum contraction 30uv (0%).

Same table results also indicate that working muscles highest contribution percentage in (Step) were Quadriceps femoris muscle - vastus medialis with maximum contraction 2305 uv (25%) followed by L:Quadriceps femoris muscle - vastus lateralis 760uv (13%), while working muscles lowest contribution rate were R:Gluteus maximus muscle with maximum contraction 85uv (1%).

Same results also indicate that working muscles highest contribution percentage in (jump) were R:Quadriceps femoris muscle - vastus medialis with maximum contraction 5456uv (30%), followed by L:Gastrocnemius muscle - lateral part 832uv (11%), while working muscles lowest contribution rate were L:Gluteus maximus muscle where with maximum contraction 270uv (3%).

The electrical activity results during third exercise show that highest electrophoresis activity was in jump, reaching muscle activity value of 2787 uvs, while value in hop was 2079 uvs, and in step was 1106uvs.

Table (7)
Maximum contraction and muscle contribution rates in takeoff stage of
(hop, step and jump) for fourth exercise

Fourth exercise	(Hop)		(step)		(jump)		Measurement unit Micro volt uvs
	Maximum contraction	%	Maximum contraction	%	Maximum contraction	%	
Muscles	Max	%	Max	%	Max	%	
1R:Gluteus maximus muscle	363uv	2%	557uv	1%	454uv	1%	
2R:Quadriceps femoris muscle - rectus femoris	690uv	3%	541uv	1%	787uv	1%	
3 L:Gluteus maximus muscle	278uv	2%	275uv	1%	372uv	1%	
4L:Quadriceps femoris muscle - rectus femoris	351uv	3%	355uv	1%	325uv	1%	
5R:Quadriceps femoris muscle - vastus lateralis	2931uv	18%	7704uv	21%	7875uv	22%	
6R:Quadriceps femoris muscle - vastus medialis	3648uv	26%	7737uv	24%	8005uv	26%	
7 R:Gastrocnemius muscle - lateral part	2570uv	15%	7502uv	20%	7875uv	22%	
8 R:Tibialis anterior muscle	2639uv	17%	7782uv	21%	8017uv	22%	
9 L:Quadriceps femoris muscle - vastus lateralis	672uv	4%	744uv	2%	1136uv	1%	
10 L:Quadriceps femoris muscle - vastus medialis	465uv	3%	1137uv	3%	500uv	1%	
11 L:Gastrocnemius muscle - lateral part	675uv	6%	759uv	3%	900uv	2%	
12 L:Tibialis anterior muscle	432uv	3%	691uv	2%	526uv	1%	
Overall work area	3765 uvs		7766 uvs		13487 uvs		

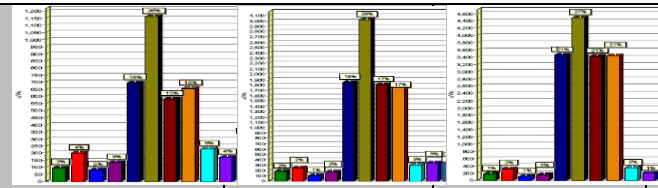


Table (7) results reveal that working muscles highest contribution rates in (Hop) were R:Quadriceps femoris muscle - vastus medialis with maximum contraction 3648uv (26%), followed by Quadriceps femoris muscle - vastus lateralis maximum contraction 2931uv (18%), while working muscles lowest contribution rate were Gluteus maximus muscle with maximum contraction 278uv (2%).

Same results also indicate that working muscles high contribution rates in (Step) were R:Quadriceps femoris muscle - vastus medialis with maximum contraction 7737uv (24%) followed by R:Tibialis anterior muscle 7782uv (21%), while working muscles lowest contribution were L:Gluteus maximus muscle with maximum contraction 275uv (1%)

Same results also indicate that working muscles highest contribution percentage in (jump) were R:Quadriceps femoris muscle - vastus medialis with maximum contraction 8005uv (26%) followed by R:Tibialis anterior muscle 8017uv (22%), while working muscles lowest contribution rates were L:Quadriceps femoris muscle - rectus femoris with maximum contraction 325uv (1%).

Muscles electrical activity results during fourth exercise performance show that the highest electrophoresis activity was in the jump reaching muscle electrical activity of 13487 uvs, while the value in step was 7766uvs, and in hop was 3765uv

Table (8)
Maximum contraction and muscle contribution rates in takeoff stage of
(hop, step and jump) for fifth exercise

Fifth exercise	Figure shows working muscle in takeoff phase (hop, step, jump)					
	(Hop)		(step)		(jump)	
	Maximum contraction	%	Maximum contraction	%	Maximum contraction	%
Muscles	Max	%	Max	%	Max	%
1R:Gluteus maximus muscle	479uv	2%	404uv	1%	540uv	0%
2R:Quadriceps femoris muscle - rectus femoris	704uv	3%	788uv	2%	237uv	1%
3 L:Gluteus maximus muscle	302uv	0%	85uv	0%	377uv	1%
4L:Quadriceps femoris muscle - rectus femoris	443uv	1%	188uv	1%	616uv	1%
5R:Quadriceps femoris muscle - vastus lateralis	510uv	17%	7478uv	21%	7948uv	26%
6R:Quadriceps femoris muscle - vastus medialis	8004uv	33%	7253uv	20%	7829uv	21%
7 R:Gastrocnemius muscle - lateral part	5157uv	16%	7200uv	20%	7866uv	21%
8 R:Tibialis anterior muscle	4978uv	15%	7539uv	20%	8017uv	22%
9 L:Quadriceps femoris muscle - vastus lateralis	656uv	3%	498uv	1%	1302uv	2%
10 L:Quadriceps femoris muscle - vastus medialis	735uv	2%	426uv	1%	1019uv	2%
11 L:Gastrocnemius muscle - lateral part	2205uv	6%	3948uv	12%	4091uv	7%
12 L:Tibialis anterior muscle	629uv	1%	217uv	1%	863uv	1%
Overall work area	6091 uvs		5387 uvs		16850 uvs	

Measurement unit
Micro volt uvs

Table (8) results reveal that working muscles highest contribution rates in (Hop) was the muscle were R:Quadriceps femoris muscle - vastus medialis with maximum contraction 8004uv (33%), followed by R:Quadriceps femoris muscle - vastus lateralis 5101 uv (17%), while working muscles lowest contribution rate were L:Gluteus maximus muscle with maximum contraction 302uv (of 0%).

Same results also indicate that working muscles highest contribution percentage in (Step) were Quadriceps femoris muscle - vastus lateralis with maximum contraction 7478uv (21%) followed R:Tibialis anterior muscle 7539 uv (20%), while working muscles lowest contribution rate was for L:Gluteus maximus muscle with maximum contraction 85uv (0%).

Same results also indicate that that working muscles highest contribution percentage in (jump) were R:Tibialis anterior muscle with maximum contraction 8017uv (22%), followed by R:Quadriceps femoris muscle - vastus lateralis 7948uv(21%), While working muscles lower contribution rate was for R:Quadriceps femoris muscle - rectus femoris with maximum contraction 237uv (1%),

Muscles electrical activity results during fifth exercise performance show that the highest electrical activity value was in jump 16850 uvs Micro Vault, while the value in hop was 6091 uvs Micro Vault, and in step 5387uvs the Micro Vault.

3- Second and third queries discussion: -

We note through muscle electrical activity analysis that the most important working muscles in (1st and 2nd exercises) are R:Quadriceps femoris muscle - vastus lateralis, R:Quadriceps femoris muscle - vastus medialis, R:Gastrocnemius muscle - lateral part, R:Tibialis anterior muscle, and R:Quadriceps femoris muscle - rectus femoris and are the same working muscles in triple jump and almost with the same values of muscles maximum contraction values. While in (3rd, 4th, and 5th) exercises the most important working muscles are R:Quadriceps femoris muscle - vastus lateralis, R:Quadriceps femoris muscle - vastus medialis, R:Gastrocnemius muscle - lateral part and R:Tibialis anterior muscle. Maximum contraction value is significantly higher than those in 1st and 2nd exercises; this may be due to higher tools used used in 3rd, 4th and 5th exercises, this led to an increase in the burden on muscles, making the free leg movement more strongly as a result of

increased height; as the work requires free leg withdrawal backward and takeoff leg forward and upward and then stretching it forward to touch the land

Mohamed Hassan Allawi (1990, p294) and Essam Abdel-Khalek (1994, p18) confirmed that exercises similar to skills performance nature are similar in motor composition with movements performed by player within sports competition in terms of power, speed, force time path, muscle work direction with movements performed, i.e. featured by dynamic match between its path and motor skill technique path using the same working muscle groups in the skill itself. Bastawisy Ahmed (1997, p319) also confirms that to develop triple jump; performance approach speed should be reached to highest level possible, improving takeoff level for both feet, and enhance motor coordination between the three jumps.

Mohamed Shawky, Amr Allah Ahmad (2002) results confirmed that using similar movements led to an improvement in vertical jump level due to using directed exercises and the same working muscle groups. Also Casey

Wilson et al (2009, p277-282) which studied kinetic models for triple jump exercises emphasized that muscles and physical requirements in exercises should be similar to those in triple jump competition.

Electrical activity measuring results during hop, step and jump performance, reveal that electrical activity values were higher in (3rd, 4th, and 5th) and this is due to that as tools high is simple as the muscles overall work area is less and vice versa. This is what we observe in the (1st, and 2nd) exercises. If the height increased overall work area increased and other muscles contribute with larger percentage as in (3rd, 4th, and 5th) exercises and so we find that whenever tools height is simple same muscles works as per triple jump muscles arrangement. This answer second and third queries.

Tables (4,5,6,7,8) that indicates that the lowest contribution percentage was for R:Quadriceps femoris muscle - rectus femoris, and L:Gluteus maximus muscle with very low values, which advocated the need to subdue these muscles to training program for motor speed of response development to activate basic motor units.

4- Fourth hypothesis results:

Table (9)
Velocity indicator value for lower limb center of gravity (COG) for takeoff phase
(hop, step, and jump) for triple jump competition

Take of moment	Hop in triple jump			Step in triple jump			Jump in triple jump		
	Horizontal velocity	Vertical Velocity	Velocity resultant	Horizontal velocity	Vertical Velocity	Velocity resultant	Horizontal velocity	Vertical Velocity	Velocity resultant
	Vx[cm/s]	Vy[cm/s]	V[cm/s]	Vx[cm/s]	Vy[cm/s]	V[cm/s]	Vx[cm/s]	Vy[cm/s]	V[cm/s]
Frames Variables	Time (0.033 : 0.233)			Time (0.6: 0.733)⊙			Time (1:12)		
	Frames (1-8)			Frames 19-23			Frames 31-37		
Body COG	-560.772	124.165	-575.075	-556.127	102.107	-534.863	-459.216	120.767	-396.923
Thigh COG	-573.432	132.291	-538.631	-524.349	85.222	-506.66	-555.84	78.449	-399.118
Shank COG	-811.813	123.889	-791.587	-534.201	210.654	-522.161	-665.75	138.464	-436.724
Foot COG	-1050.9	-158.612	-1050.15	-511.33	366.865	-580.465	-742.234	249.235	-632.774

Table (9) results reveal that highest rate of Body COG was in hop followed by step, the lowest rate in jump, also velocity resultant for lower limb was at highest rate in hop

and lowest rate in the jump, and resultant speed for step were between hop and jump except for foot where resultant speed in step is less than in the jump.

Figure (2)
Velocity indicator value for lower limb center of gravity (COG) for takeoff phase (hop, step, and jump) for triple jump competition

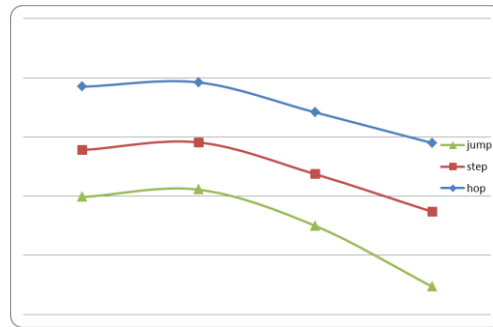


Table (10)
Force indicator value for lower limb center of gravity (COG) for takeoff phase (hop, step, and jump) for triple jump competition

Take of moment	Hop in triple jump			Step in triple jump			Jump in triple jump		
	Horizontal force	Vertical Force	Force resultant	Horizontal force	Vertical Force	Force resultant	Horizontal force	Vertical Force	Force resultant
	Force-x[N]	Force-y[N]	Force [N]	Force-x[N]	Force-y[N]	Force [N]	Force-x[N]	Force-y[N]	Force [N]
Frames Variables	Time (0.033 : 0.233)			Time (0.6: 0.733⊙)			Time (1:12)		
	Frames (1-8)			Frames 19-23			Frames 31-37		
Body COG	-880.425	-296.489	886.06	-598.147	-452.629	662.229	-522.378	-452.719	524.016
Thigh COG	-396.133	-154.822	396.314	-310.561	-195.574	326.178	-307.804	53.857	307.959
Shank COG	-231.637	-48.025	231.909	-137.359	-112.87	162.761	-163.874	67.062	185.57
Foot COG	-103.701	-23.264	105.507	-37.693	-53.453	54.643	58.191	42.306	67.544

Table (10) results reveal that force resultant for Body COG was at highest rate in hop followed by step and was the lowest rate in jump, results also shows that lower limb force resultant were at highest rate in hop and at lowest rate in step and values of step were between hop and jump

Figure (3)
Force indicator value for lower limb center of gravity (COG) for takeoff phase (hop, step, and jump) for triple jump competition

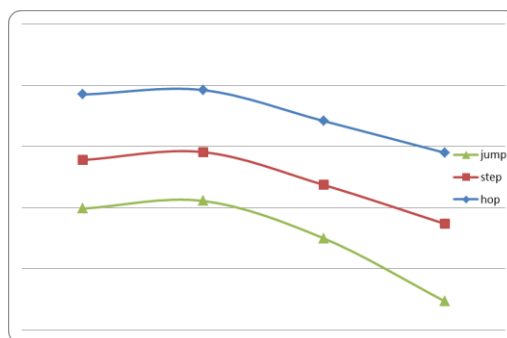


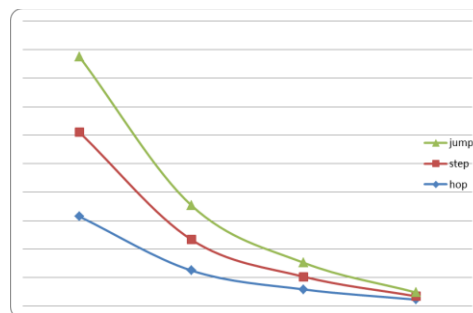
Table (11)
Impulse indicator value for lower limb center of gravity (COG) for takeoff phase
(hop, step, and jump) for triple jump competition

Take of moment	Hop in triple jump			Step in triple jump			Jump in triple jump		
	Horizontal impulse	Vertical Impulse	Impulse resultant	Horizontal impulse	Vertical Impulse	Impulse resultant	Horizontal impulse	Vertical Impulse	Impulse resultant
	Impulse-x [N/sec]	Impulse-y [N/sec]	Impulse [N/sec]	Impulse-x [N/sec]	Impulse-y [N/sec]	Impulse [N/sec]	Impulse-x [N/sec]	Impulse-y [N/sec]	Impulse [N/sec]
Frames Variables	Time (0.033 : 0.233)			Time (0.6: 0.733 [⊙])			Time (1:12)		
	Frames (1-8)			Frames 19-23			Frames 31-37		
Body COG	-156.905	32.576	157.318	-145.907	26.789	147.977	-130.507	31.685	132.667
Thigh COG	-61.35	14.153	62.446	-51.346	9.118	54.096	-59.468	8.393	60.057
Shank COG	-29.243	4.463	29.341	-19.243	7.588	22.298	-23.982	4.988	24.452
Foot COG	-11.252	-1.698	11.379	-0.893	3.928	5.862	-7.947	2.669	6.729

Table (11) results reveal that impulse resultant for Body COG were at highest rate in hop followed by step and lower rate in jump, results also shows impulse resultant for lower

limb COG party were at higher rate in hop, lower in step, and jump values were between hop and step

Figure (4)
Impulse indicator value for lower limb center of gravity (COG) for takeoff phase
(hop, step, and jump) for triple jump competition



5- Fourth hypothesis discussion:

Table (10) results indicates that muscles involved in hop, step, and jump, are the same muscles but in different values for maximum contraction. At the same time we note that velocity resultant is lower in step and jump than hop, which is due to that maximum muscles activity affect velocity level. It also noted that there is negative correlation between horizontal and vertical velocities. Where Body COG at takeoff phase in hop horizontal velocity was -305.03 cm / s, and vertical velocity was 124.165 cm / s, step there was an increase in horizontal velocity to - 349.027 offset by a decrease to 102.107 cm / s, and then horizontal velocity decreased in jump and reached 300.075 - cm / s offset by increase in vertical velocity to 120.767 cm / s.

This result is consistent with the James.G.Hay, and Peng Yu Bing (1996, p1283-1289) mentioned that the greater profit in the vertical velocity the greater loss in horizontal velocity also found that the loss in horizontal velocity is large in impulse phase and there is a positive linear relationship with an vertical velocity increase during impulse itself

These findings are consistent with Wehbe Alwan Hassoun and Osama Ahmed Hussein (2009) study which proofed that electrical activity of Quadriceps femoris muscle - rectus femoris is an evidence of standing angle increase, as well as that horizontal velocity decreased at the beginning of takeoff moment and then increased at the end of the phase , and these results are consistent with Fukashiro & Miyashita (1981) study results, where there was decreased horizontal velocity during the first half of each take-off and increased during the second half, also Abdul Rahman Abdul Hamid Zahir (2000, p35) mentioned that increase the vertical composite correlate directly with decrease in horizontal composite to address jump flight range.

Al-Kilani MA, Widule CJ (1990, p267-270) argued that horizontal velocity in step stage, as well as vertical velocity in hop and step affect jump total distance. This is confirmed by Bastawisy Ahmad (1997, 325) that takeoff period in step is larger than in hops (5: 325). Qassim Hassan (1999) in the opinion that horizontal velocity in the third jump is very important and velocity loss should be fixed during this hump

Table (11) results reveals that force resultant was less in step and jump than hops; this is due to that muscles maximum activity affect force of (hip, leg and foot). These results agree with Fukashiro & Miyashita (1981, 233-237), where they reached that the player must make the horizontal force amounted of 3.6 to 4.4 times of his weight each takeoff time . These results also agrees with Mohamed Abdel Aal et al (2000 , p166) (2001, p180), Mohamed Shawky and the command of Allah Ahmad (2002, p220) that direction to specialty and using muscle abilities gained from plyometric training programs has shown a positive impact in improving movements similar or origin per share

Impulse resultant were also lower in step and jump than I hop; this is due to that muscles maximum activity affect (hip, leg, foot) level. This is confirmed by Bastawisy Ahmad (1997, p318-319) where he argues strong and rapid impulse with takeoff foot help to complete the movement in the lowest possible time from one hand, and from the other reducing losing velocity gained from approaching.

It is noted that there are 8 frames for takeoff moment in hop, 5 frames for step and 7 for jump. i.e. hop time and frames are larger than step and jump. This is due to that the aim of hop is performing low flight for long distance while minimizing loss of horizontal velocity, where free leg thigh is swinging to horizontal position and towards takeoff leg forward and not upward with pulling free leg forward and upward then extends to front in preparation to touch the ground. (International Athletic Federation for Amateurs: , p90)

This is confirmed by Bastawisy Ahmad (1997, p235) that the period of takeoff phase is larger in step than hop

Tables (10), (11), (12) show that there are correlations between muscles maximum contraction and speed, power and impulse resultants for all joints under discussion. Therefore coaches must pay attention to develop muscles working in skill direction of performance to save player's effort. Bastawisy Ahmad (1997, p318-319) confirms that force and velocity elements play positive and important role in triple jump. Three jumps in a row with different rhythms means a difference in application of mechanical foundations that achievement level, so it should be taken into account to get proper angle, either at the beginning of foot setting, or impulse at takeoff phase, Center of gravity arrive to highest appropriate flight distance, coupled with the most appropriate angle of flight, achieve the greatest possible distance. This answers the fourth query.

Conclusions:

- Muscles electrical activity analysis of triple jump competition , we find that the most important muscle are Quadriceps femoris muscle - vastus lateralis, Quadriceps femoris muscle - vastus medialis, Gastrocnemius muscle - lateral part, and Tibialis anterior muscle

- Electrical activity measuring results during hop, step and jump performance in triple jump competition reveal that highest activity electrophoresis activity was in step with value of 681uvs Micro Vault, while value for hop was 128 uvs Micro Vault , and for jump was 335 uvs.
- That most important muscles working in (1st and 2nd) exercises vastus are Quadriceps femoris muscle - vastus lateralis, Quadriceps femoris muscle - vastus medialis, Gastrocnemius muscle - lateral part, Tibialis anterior muscle and Quadriceps femoris muscle - rectus femoris which are the same working muscles in triple jump and almost with the same of maximum contraction values. Working muscles in (3rd, 4th and 5th) exercises were Quadriceps femoris muscle - vastus lateralis, Quadriceps femoris muscle - vastus medialis, Gastrocnemius muscle - lateral part, and Tibialis anterior muscle
- One of the most important results that that working muscle in the competition are consistent with characteristics of electrical activity of (1st and 2nd) exercises, giving more confidence in muscle strength exercises that rely on specific exercises similar to performance nature.

Recommendations:

- Coaches should not overstate heights which player trained on as it helps muscles involved in performance to work in high load- in addition to other muscles work with greater proportion than muscle necessary for work.
- Emphasis on " principle of privacy " application that most of focus in training programs to be on muscles most involved in specific muscular work this focus be on muscular contraction nature.
- More interest to be given to develop exercises similar to technical performance in terms of muscle shape and work to develop physical and skill fitness elements while designing training programs.

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