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The Effect of Rehabilitation Exercises and Electric Muscle Stimulation (X Body) on Optimizing Leg Connective Muscles Strength and Biomechanical variables for Injured Athletes

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Abstract

This study is aiming to prepare therapy exercises to rehabilitate the injured hip joint connective muscles and treating exercises by Electric Muscle Stimulation (X Body) or EMS. Based on that, the leg biochemical variables need to be determined. An experimental method was used to discover the best solution for this case study. 10 injured athletes with connective muscle rupture (middle class injury) were selected. The samples were divided into two groups; the first group contained 5 athletes following a rehabilitation training program with EMS and the second group was also 5 athletes following a rehabilitation training program with no EMS.

The variables studied are the maximal force of connective muscles (MFCM) measured by (kg), maximum power recorded (MPR) on power measurement platform by (Newton), angular velocity of the articular joint (AVAJ) and maximum height of the hip joint (MHHJ) by (cm). The apparatuses used for this purpose are a power measurement platform, video recording and a biomechanical analysis program (KINOVEA). Afterwards the data is processed by a SPSS-23 statistic program.

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Introduction

Sports medicine is playing the main role in sports injuries and is making impressive improvements. The most important part of the medicine explains functional, anatomical and mechanical aspects of body operation in movement activity. One of the cases in team sport is that the players are exposed to high injury possibilities due to high and continuous strength on body organs and wrong technical skills. Warming up before any

performance is important and should take place. Likely, injury is occurred when the scientific and technical training conditions are not considered. Therefore, first aid and diagnosis of medical injury needs to be prioritised in this occasion, then modern and scientific methods of treatment have to be followed. The rehabilitation training and treatment considered is a type of sport medicine when the academics and experts are interested in this field implementation. Science of Anatomy and the functionality of organs and other type of medical science are all important to understand and develop sport. Treating exercise is a group of movements with physiological effect with a preventive treatment aim to retain the human body to the natural situation and keep it healthy.

On the other hand, EMS is an effective scientific method to help injured muscle to recover and to function in a better way and gain special characteristics. EMS is increasing the rate of functionality of internal organs via muscle excitation and subcutaneous nerve excitation and blood flow will rise as a result. Injury of connective muscles rupture the internal side of the thigh is widely spread in sport medicine. These muscles are group of five muscles called connective muscles as they combine thigh inward and connected to the pelvic bone from the inner side and the other side is connected to thigh bond. This muscle injury is caused by a stiffness or rupture due to pressure on the nourishing nerve and the signal is getting weak which causes less response. There is a high possibility it will be associated with an inflammation in the Ganglion cysts of the muscles. This is a normal result of iterated excitation of Flexor while performing activities depend on connective muscle. In some case hot weather and high temperature cause bone infection and it may affect the connective muscle. Overall, the result of a muscle injury is a mechanical problem like short range movement and muscle stress. Other type of result is unbalance in strength between connective muscles and supportive muscles and slow speed muscle signal.

Athletes are likely suffering from this type of injuries mostly because of bad excerise and discontinuation of exercising. This study is to determine how effective the rehabilitation exercises are and the EMS treatment by using (X Body) apparatus in recovering injury after defining the place of dysfunction and weakness in motion performance and muscle activity.

Worthwhile for today research - as it is in high demand - is the kinetics and kinematics analysis to understand ways to improve athletes' performance. Sinclair et al., recently studied the effect of patellar strap on knee joint during the jump landing. Biomechanical

parameters were determined, and Bayesian analyses were used in this study. The results show that there were no improvements in weight bearing knee proprioception in using or no using patellar strap [1]. Sinclair et al., also implements different techniques to study biomechanical parameters. Musculoskeletal simulation analysis was used to determine the kinetics and kinematics of different orthoses on lower extremity. The parameters were linked to the aetiology of chronic running injuries [2].

Yong-Seok Jee, studied the efficiency of whole body-electromyostimulation (WB EMS)[3].

The experimental work focused on Electrical muscle stimulation device, the improvement of the cardio- pulmonary factors and psychophysiological indications. It has been confirmed that the systolic blood pressure SBP is improved, oxygen uptake in submaximal and maximal stages of graded exercise test GXT is also improved. This study confirms that 6 weeks of WB-EMS training can improve psychophysiological factors.

Consequently, the research in this field is so important and finding better methods for rehabilitation exercises with X body to rehabilitate the five muscles of thigh for middle class injuries. The aim is to determine the effective developments in biomechanical variables.

It is worth to mention that the difficulty in this study is the use of the scientific facilities for the purpose to achieve the objectives and therefore can speed up the recovery process and bring you back to playgrounds faster. Researchers tried their best to integrate the mechanical ability and movement performance of lower limp.

Study objectives can be summarised as follows:

1- Prepare a set of training exercises to rehabilitate the connective muscle for thigh injured joints and to improve the biomechanical variables for the lower limp.
2- Prepare a set of sport exercises with EMS (X Body) treating for the same purpose.
3- Determine the effect of those exercises on biomechanical variables.
4- Study the effectiveness of EMS (X Body) in rehabilitating the damage.
5- Compromise between the two types of treatments.

The researchers assumed some positive foundational assumptions with an initial preparation for accessing and to carry on with this study:

1- The effect of this type of treatment is positive.
2- All treatments associated with EMS are more positive and preferable.

Method

An experimental study approach was selected to for the purpose of satisfying the research program.

Two sampling groups (experimental and monitored) were nominated, injured athletes were chosen from different Basra city football teams of futsal having similar middle-class injuries (rupture of the connective muscles of the thigh). For the purpose of equivalent sampling, the injured footballers are all from Iraqi Premier League for the sports season 2018/2019,the clubs (The Mena'a, South Oil and The South) and there is no entrance of different between the research 10 samples (5 samples each) and that make the result highly realistic.

The following tests were used to examine the research sample:

1- Maximal force of connective inner thigh muscles (MFCM) test by calculating the force using the hip adduction machine that undergoes the adductor muscle groups on inner thighs.

The test is to hang a certain weight on the inner side of the thigh with 90^o knee angle during the sitting position in an adduction machine and this is suitable to push in exercise. Resistance value is recorded in the kg unit and it will be considered as an optimum muscle force in both of the primary and final tests.

2- Force test apparatus (made in Netherland) was used to examine the maximum power of the lower limb. The apparatus is connected to the fast processer (Cori 5) computer. The apparatus contains 4 weight sensors measuring the force to the maximum value of $7848\ N$. It is supplied by $(180-220\ V)$ and (logger pro3) to be connected to the computer. This set up can read the signals as curves to measure maximum power on the platform [4]. The athlete stands up on the platform and then jump vertically upward.

3- Video recorder (Sony Hdr-XR520) with force faster device $(100fps)$and Kinovea motion analyser is used to determine the kinematics variables. The variable needs to be measured is related to the vertical jump via motion analysis. Angular transition of the knee joint in a certain time (angular velocity) is measured by (rad/s) [5]. The highest joint point can be recorded which is the highest vertical transition point on the platform.

A specific sample weight (mass), tallness and leg length were applied in selection. Coefficient of variation was calculated to ensure homogeneity of individual samples. Coefficient of variation is in the range of $(3.191 - 10.069)$ and this is less than 30% of the average value which indicates variation is acceptable and the sampling consider to homogenic [6].

The two went through the same rehabilitation exercises and program. The program is 3 training units every week and for 8 weeks. The program started after 7 days of the primary test took place for the two groups. Facilities of Physical Education and sport faculty of Basra University were used for training units and test program.

Table (1) shows the type of the training unit and selected exercises with the time period for each.

The two groups followed the same training 19 sessions program, but the experimental group used EMS (X Body) 20 minutes before starting exercise and the final test was followed by 10 weeks. All collected result were transferred to be analysed by (SPSS-v23).

Exercise	Performance Time (sec)	Iterations	No of units	period between units (sec)
Tapes Rubber Ropes	60	15	4	30
Ball Balance	60	15	4	30
Machine Adduction	60	20	4	30
Machine Abduction	60	20	4	30
Leg Curl Machine	60	12	3	30
Glute Machine	3	15	3	30
Machin Leg Press	5	15	2	30
Machin Hack Back	45	12	4	30
Tension Machine Calf Ext	45	15	4	30
Seated Machine Back Extension	45	12	4	30
Half Ball Balance	45	15	4	30
Machine Angled Leg Press	45	20	4	30
Power Squats	45	10	4	30
Front Squats	30	12	3	30
Dumbbell Squats	30	12	3	30
Sumo Deadlifts	30	12	3	30
Stiff Legged Deadlifts	30	12	3	30
Floor Hip Abduction	30	12	3	30
Cable Hip Abduction	30	12	3	30

Table 1: rehabilitate exercises program (19 sessions)

Results and Discussion

The test results which we have managed to gain is illustrated in tables (2-4) including the statistics value analyses. The statistical analysis values will determine whether these results are correct or not and the extent of research achievement, hypotheses and objectives.

Variables	Primary Test			Final Test			T test	Sig
	Mean	Standard Deviation	Error	Mean	Standard Deviation	Error		
MFCM (kg)	58	15.247	6.819	152	12.549	5.612	17.608	0.01
MPR (N)	363	13.509	6.041	530	27.386	12.247	11.096	0.02
AVAJ (rad/s)	1.79	0.08	0.04	3.92	0.130	0.058	26.625	0.00
MHHJ (cm)	116	5.481	2.352	145	6.123	2.738	6.742	0.003

Table 2: Statistical treatments of the variables of the primary and final tests for the monitored group.

Variables	Primary Test			Final Test			T test	Sig
	Mean	Standard Deviation	Error	Mean	Standard Deviation	Error		
MFCM (kg)	56	15.165	6.782	169	8.944	4	25.924	0.00
MPR (N)	374	20.736	9.273	622	19.235	8.602	18.801	0.01
AVAJ (rad/s)	1.94	0.114	0.05	4.150	0.165	0.074	23.16	0.00
MHHJ (cm)	122	5.70	2.549	154	5.477	2.449	6.532	0.003

Table 3: Statistical treatments of the variables of the primary and final tests for the experimental group

Variables	Monitored Group			Experimental Group			T test	Sig
	Mean	Standard Deviation	Error	Mean	Standard Deviation	Error		
MFCM (kg)	152	12.549	5.612	169	8.944	4	2.467	0.03
MPR (N)	530	27.386	12.247	622	19.235	8.602	6.147	0.00
AVAJ (rad/s)	3.92	0.130	0.058	4.150	0.165	0.074	2.438	0.04
MHHJ (cm)	145	6.123	2.738	154	5.477	2.449	2.449	0.04

Table 4: Statistical treatments of the variables of final test for the two groups

What we have seen from table (3), is the clear development in experimental group result when to monitoring group results. ESM treatment shows that the $(P.value = 0.00)$ is between the primary and the final test and this means a significant difference is taking place between the two tests as it is less than 0.05. This is also confirmed in table (4) as the result shows a significant conclusion for the experimental group $(P.value = 0.03\ less\ than\ 0.05)$.

For certain this result is related to the motional-sense nature of the muscles and effectively adjusts movement performance between working and opposing muscles which leads to the improvement in muscular-nervous compatibility. The resultant compatibility is indicating the robust harmony with these muscle groups.

Abu Alula M., states that the increase in muscle power is strongly referred to compatibility between the muscles involved in one performance. The performance depends on the central nervous system regulating the internal compatibility of those muscles via a number of operating units, rate of nerve excitation frequency and the temporal relationship between the work of motional units [7]. On the other hand, Amen M. et al, confirmed the positive effect of ESM which plays such a role in rising performance level via improving the internal operation rate by exciting the muscle group. Muscle contraction increases blood flow to the muscle damage position and this is the basic results of ESM [8].

Maximum power recorded (MPR) on power measurement platform is significantly approved for the experimental group. The different between the primary and final test results shows in Table (3) given a probability value of $(P.value = 0.01 < 0.05)$. Table (4) confirmed the same result, where $(P.value = 0.00 < 0.05)$ for the final test of experimental group. Connective muscles ability and strength of the lower limb muscles is definitely better than before ESM exercises used. The injured player is applying more power on the power measurement platform in absorption stage by bending in the knee joint and to be ready for the second stage. Second stage is pushing to stand up and the bent in knee joint force the player to open his/her hip angle. The ability of opening hip angle is certainly back to normal as it is directly connected to the connective muscle and MPR recorded value is improved as a result. This outcome has been approached by Abdul Karim S. as he mentioned that there is a possibility to increase the MPR by reducing pushing time and increasing body pushing speed. This is indicating the development in nervous-muscle system which is considered as a principle requirement

for player performed fastly [9]. Basic principle is to shorten the action pushing time leads to a higher vertical power. First requirement in this manner is producing an optimum power within maximum movement range and highest possible rate of speed [10].

Knee angular velocity is also shown a significant result as indicated in table (3) and (4) and is quite similar to what we have explained previously. This is a clear reference to ESM (X Body) used for $20\,min$ before start exercising which significantly raised the level of nerve signals within the infected muscle. Thus, stimulating the injured muscles and the auxiliary muscles close to the injured part leads to improvement in muscle capacity, reducing atrophy and muscle weakness during injuries, increasing motion range and speed of the shrinkage movement units. Electrical stimulation develops the power locally in the infected muscles and it is used to alert the nerves and muscles during the duration of the injury. ESM is maintaining muscle efficiency and vitality during injury; muscle vibrational tone and it has a positive effect to restore normal muscular compatibility [11].

Mechanical, mobilizing and recruiting largest group of muscle fibber in shorter time is producing muscle strength in the lower limb and achieve a greatest amount of mechanical energy. Knee joint will be able to work in various angles and larger range motion in a shorter time. Larger Angle displacement between two phases (knee joint, maximum flexion and maximum extend) is increasing the angular velocity to complete the motion and full legs extend. Transfer the generating motion smoothly and within shorter time following equation 1[12]:

$$Angular\ Velicity = \frac{Angular\ displacment}{Time} \ldots\ldots\ldots\ldots\ldots (1)$$

Hip joint is getting healthier and the joint functioning is back to normal due to the final test results of experimental group. However, maximum height of the hip joint (MHHJ) is certainly approaching better height as a result of healthy recovery. Table (3) and (4) are shown $(P.value = 0.01\ and\ 0.04)$ consequently, and this for sure is a significant level as it is (< 0.05).

Muscle power improved means motion speed reaching a greater value and athlete achieves a larger vertical distance in less time. Therefore, the ability of generating a good level of power means higher performance speed and motion. Acceleration is directly promotion to power on the direction of movement (second Newton law) [13].

Conclusions:

As per of our research results, data statistical and discussions, we can summarise this study conclusions as follow:

1- Rehabilitation Exercises associate with ESM (X Body) is positive and recommended to recover this type of injury.
2- ESM give such a good level of improvement to connective muscles. As a result, all variables studied are improved.
3- Maximal force of connective muscles (MFCM), maximum power recorded (MPR) on power measurement platform, angular velocity of the articular joint (AVAJ) and maximum height of the hip joint (MHHJ) are better value for experimental group more than monitored group by approximately $(10 - 12\%)$.

Compliance with ethical standards

Conflict of interest

The author(s) declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards

References

[1] Sinclair J K, Paul J T, Brooks D, Glenn T, Butters B, (2019) Effects of a patellar strap on knee joint kinetics and kinematics during jump landings: an exploration using a statistical parametric mapping and Bayesian approach, Sport Science and Health, In press.

[2] Sinclair J K, Ingram J, Paul J T, Chockalingam N, (2019) Acute effects of different orthoses on lower extremity kinetics and kinematics during running; a musculoskeletal simulation analysis, Acta of Bioengineering and Biomechanics, In press.

[3] Jee YS, (2018) The efficacy and safety of whole-body electromyostimulation in applying to human body: based from graded exercise test, Journal of Exercise Rehabilitation, 14(1), pp49-57.

[4] Ali IA, (2015) Biomechanical variables analysis, nerve signal variables and indicators of the work of mechanical sensory receptors in snatch weightlifting-young weightlifters, PhD thesis, Faculty of physical education and sport, Basra University
[5] Shaban ZN, (2015) Function analysis of (power-time) with biomechanical gymnastic variables-backflip, PhD thesis, Faculty of physical education and sport, Basra University
[6] Alneami MA, Albaiati HM, (2006) Advance statistics in educational sciences and physical education with SPSS applications, Addition 1, Alwaraq for publications, Jordan
[7] Alawi MH, Abdu Alfatah AA, (1997) Sport physiology and athletes' health, Addition1, Cairo, adn 1, Cairo, Dar Alfiker Alarabi
[8] Amin EM, Zain AD, (1987) Effects of electrical stimulation in the preparation of beginners' swimmers for competition, 1st Conference of Female faculty of Physical Education, Cairo, Volume 3
[9] Alkarim SA, (2010) Biomechanics applications in sports training and motion performance, Addition 1, Dar Dijlah, Aman
[10] Ahmed FA, Yakub LR, (2016) The principles of fitness, physical, functional and mechanical, Alnoor Office, Baghdad
[11] kahn J, (1991) Principles and practice Electrotherapy, Churchill living ton. Inc.
[12] Atiah UF, (2014) Study analysis of biomechanical variables in vertical jump (Basketballers) according to nerve conductive speed, Al Qadsia journal of physical education science, Volume 14, Issue 1, Part 1
[13] Hussain KH, Mahmood ES, (1998) Principles of mechanical foundations of sports movements, adn 1, Dar Alfiker for publication